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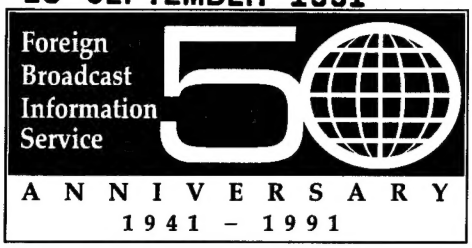

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Science & Technology

Japan

STATUS OF PROMOTION OF BIOTECHNOLOGY R&D

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STATUS OF PROMOTION OF BIOTECHNOLOGY R&D

91FE0508 Tokyo STATUS OF PROMOTION OF BIOTECHNOLOGY R&D in Japanese Jul 90 pp 1-74

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91FE0508A Tokyo STATUS OF PROMOTION OF BIOTECHNOLOGY R&D in Japanese Jul 90 pp 1-74

[Book by Biotechnology Division, Secretariat of Agriculture, Forestry and Fisheries Technology Conference Status of Promotion of Biotechnology R&D, Tokyo, 1990, 111 pages]

[Text] **I. Definition and Significance of Biotechnology in the Field of Agriculture, Forestry and Fisheries [AFF]**

1. Definition of Biotechnology

Biotechnology is a composite word of "biology" and "technology." In general, it means a technology of efficient utilizations of functions of living things. AFF industries in which humans act on the nature of living things to produce crops, livestock, and fishes, or the technology of food production by application of fermentation can be, in a broad sense, biotechnologies. But here it means a technology to utilize or improve functions of living things by acting directly on cells or genes. The major techniques can be roughly divided into 1) manipulation of genetic instructions, 2) manipulation of development and differentiation, and 3) utilization of other biological functions.

2. Significance of Biotechnology

(1) "Manipulation of Genetic Instructions" is a technology to manipulate the instructions controlling heredity, the most basic life phenomenon of living things, at the chromosomal and DNA levels, the cellular genes themselves, unlike past manipulations at the level of whole body or aggregate. It includes gene recombination and cell fusion.

Gene recombination is a technology that removes the targeted, specific gene from one living thing and inserts it into another living thing to impart a new feature. The characteristic of this technology is that the improvement in a crop or microorganism can be efficiently accomplished by inserting only the targeted gene. It is called the central technology of 21st century biotechnology, and is being regarded as a frontier technology. But in the medicinal field, practical applications have been achieved in productions of human insulin and human growth hormone by the use of *E. coli*.

Cell fusion is a technology to make a new cell by fusing together two different kinds of cells with an electric pulse or treatment with a fusion promoting agent or others. Using this technology, crosses of hybrid plants, mushrooms, yeasts, etc., that could not be mated in the past can be obtained. Moreover, it is applied in the production of highly sensitive monoclonal antibodies used in disease diagnoses from animal cells.

(2) "Manipulation of Development and Differentiation" is the technology to control the developmental processes of egg and sperm cells, the differentiation of fertilized eggs, and their further differentiations into organs and tissues. It includes manipulations of eggs and embryos, and cell and tissue cultures.

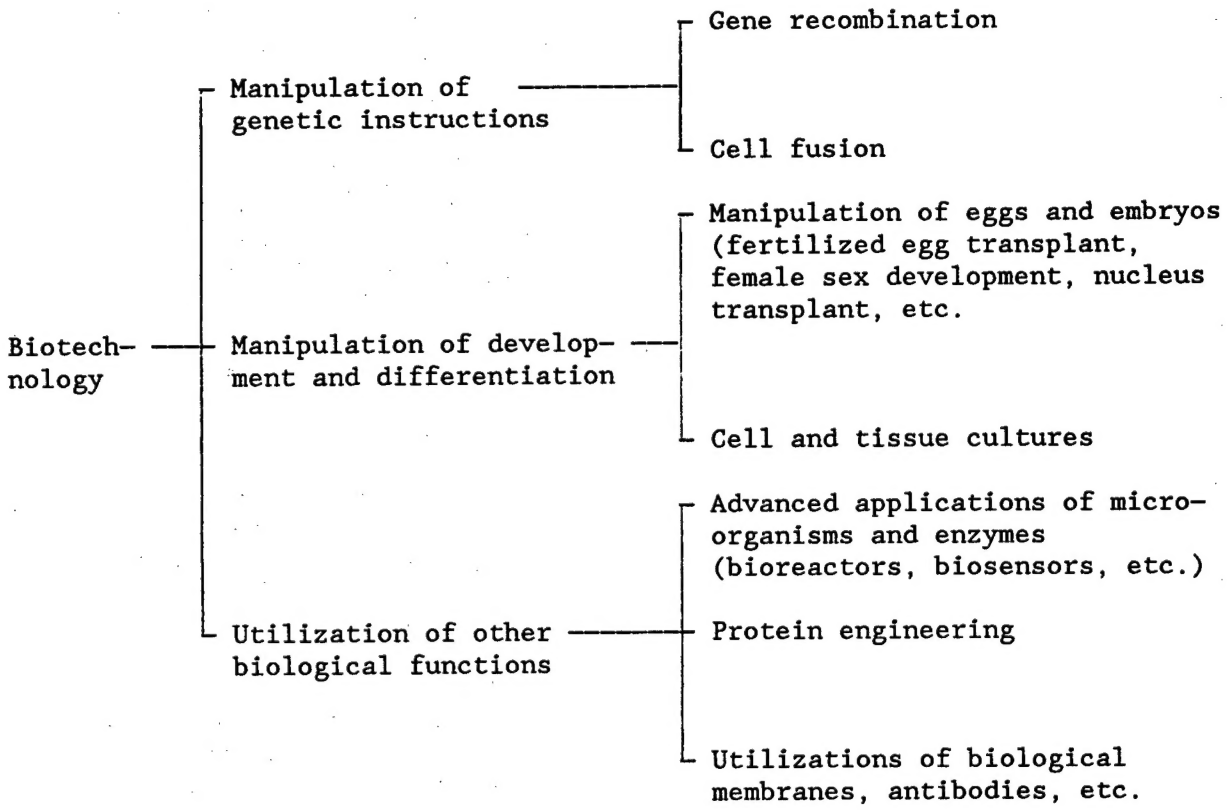
Examples of manipulations of eggs and embryos are fertilized egg transplant and test tube insemination mostly done with cattle, and development of female sex in controlling the sex of marine animals.

Cell and tissue cultures are technologies to culture and propagate animal and plant cells or tissues in an agar or another liquid culture medium. Particularly for plants, it makes possible regeneration of a plant from a single cell. It is applied in the production of rice seedlings. Moreover, animal and plant cells are cultured in tanks for the large-scale productions of dyes or medicinal ingredients.

(3) "Utilizations of Other Biological Functions" include advanced technologies that utilize microorganisms and enzymes in bioreactors or biosensors; protein engineering that aims to improve enzymes through molecular designing based on the understanding of the functions and structures of the proteins; and the technologies to utilize antibodies in the immune system and the characteristically highly functional membrane structures of living things.

As indicated above, biotechnology is to efficiently extricate functions of living things or to alter them for practical use. The fields of its application are wide ranging.

3. Major Techniques of Biotechnology



II. Recent Trend of Biotechnology in the AFF and Food

1. Status of R&D in Biotechnology

(1) Trend of R&D

1) Industrialization of biotechnology is making further progress in the production of food and beverages from improved brewer's and baker's yeasts obtained by cell fusion, and in commercialization of new varieties obtained by applications of embryo culture, anther culture, and cell mutation. At the same time, progress toward practical technology is expected in the development of production technology for man-made seeds of agricultural crops, in production of hybrid parental rice and vegetable lines from asymmetrical fusions, in mass production by test tube insemination of eggs from the ovaries of domestic animals, and in production of superior cattle by nucleus transplant using embryo cells. Progress has been made in new bioreactors and membrane application technology.

2) In the area of DNA recombination technology, progress in the commercialization of the products of recombinant microorganisms in the fields of medicine, chemicals, and yeast are being made. Moreover, there has been a succession of creations of highly useful recombinant plants that are

herbicide-resistant, insect-resistant, and anti-sense RNA genes containing. Up to 180 recombinant plants have been field tested, centering in the United States. On the other hand, in animals, in addition to some animals created as disease models by DNA recombination technology, sheep that produce physiologically active substances from mammary gland, etc., have been created.

(2) Trend of R&D, etc., in the Ministry of Agriculture, Forestry and Fisheries [MAFF].

1) Within MAFF, biotechnology departments have been established in all the involved divisions, starting with the National Institute of Agrobiological Resources [NIABR], and all the regional agricultural experimental stations [AES]. Comprehensive R&D is being pursued in basic and leading fields with a long-term view into the 21st century, emphasizing the cooperation among industry, universities, and governmental agencies. Particularly in recent years, research at the DNA level is being aggressively pursued as can be seen from the fact that the number of DNA recombination research projects increased from 37 in 1982 to 131 in 1988.

The major recent accomplishments in MAFF are the following:

- Elucidation of the structure of the rice gene involved in male sterility (NIABR)

- Development of a rice strain containing fire fly luciferace (NIABR)

- Commencement of experiments of TMV-resistant recombinant tomato in a non-closed system (National Institute of Agricultural Environmental Technology [NIAET])

- Establishment of a mulberry phenotype obtained by gene recombination (Sericultural and Entomological Technology Research Institute [SETRI])

- Development of basic technology of man-made rice seeds (Agriculture Research Center [ARC])

- Fruition of a cell fusion plant, "Oretachi" (Agezu Branch Station, Fruit Tree Research Station)

- Development of freeze-resistant yeast useful in making nonsugar bread (National Food Research Institute [NFRI])

- Success in transplanting bovine nuclei using embryo cells at the 16 cell stage (National Institute of Animal Industry)

- Development of monoclonal antibodies production methods using bovine cells (National Institute of Animal Health)

2) "Guidelines for Applications of Recombinant Organisms in AFF Fields" was issued on 20 April 1989 by the administrative vice-minister for AFF. This was in response to the trend of R&D in DNA recombination technology and its

becoming practical technology in the AFF fields. Its purpose is to assure safe applications of recombinant organisms and to promote their appropriate applications.

3) In various parts of this country, the tissue culture technique has been applied to the production of virus-free seedlings, mainly of strawberries in more than half the regions and prefectures of the nation. In the area of fertilized egg transplant, 3,366 calves were produced in 1988, comprising the sum total of 9,124 calves produced by this method. Moreover, along with these developments, the tasks of preparing a system of production, propagation and supply of virus-free and other superior seedlings, and promotion and popularization of technology of transplanting fertilized eggs of livestock are being carried out mainly by the regional and prefecture agricultural associations. On another side, since 1984, centering around the regional Agricultural Administrative Bureaus and regional AES, regional biotechnology conferences have been held for exchanging information on the promotion of regional biotechnology. Among these, in the Northeast Region, the "Northeast Regional AFF and Food Biotechnology Research Association" was organized as a permanent base for the activities of the involved private enterprises, universities, prefectures, cities, towns, and villages in March 1988. In the Kinki Region, the "Kinki Regional AFF Biotechnology and Other Frontier Technologies Research Promotion Conference" was organized in May 1989, and in the Kyushu Region, the "Kyushu Biotechnology Association" was organized in January 1989.

2. Major Recent Trend of The Technology

(Field of Plants)

(1) Full-scale field tests of recombinant organisms have been carried out in the United States and European nations. In Japan, experiments of recombinant tomato in a non-closed system has just been initiated.

The field tests of recombinant organisms have been carried out in earnest in the United States, Canada, Belgium, France, etc. The total number from 1986 to the end of 1989 for recombinant plants has reached 130 and for recombinant microorganisms 60.

On the other hand, in our country, the stage for the systematic field tests of recombinant organisms has just been prepared as the Science and Technology Agency [STA] indicated its thoughts on recombinant plant experiments including those in nonclosed systems at the end of 1988. In April 1989, the MAFF issued "Guidelines for Applications of Recombinant Organisms in AFF Fields" for the industrial application step. In this atmosphere, NIABR started the nonclosed system experiments on recombinant tomato plants containing the introduced tobacco mosaic rirus resistance gene in October 1989.

(2) Progress in the Development of Recombination Technology To Control The Expression of A Plant Gene

The research in applying the technology that utilizes the function of antisense RNA having the complimentary arrangement of messenger RNA to control the expression of a specific gene for plant breeding is in progress. In addition, development of a system of introduction and expression of male sterility utilizing the gene that suppresses pollen development is under way.

- Control of the color of petunia by antisense RNA (Vrije University, Holland)

- Improvement of the shelf life of tomatoes by antisense RNA (Calgene and ICI Seeds, United States)

- Development of technology of specifically expressing male sterile characteristic with chemicals (PGS Company, Belgium)

(3) Plant Breeding Utilizing Somatic Mutation Entering The Practical Stage

Utilizing the fact that genetic mutations take place with high equency in a plant callus (non-differentiated cell gregate), a breeding technique to select useful expressed features from it has reached the practical stage. Many results have been reported in Japan and other countries.

- "New female bees" from the cells of a parent female strawberry bee, a distinctive product of Tochigi Prefecture (Tochigi Prefectural AES).

- "Hatsuume," a rice variety from the parent Koshihikari cells (Research Institute of Plant Engineering)

- "Sumi Rice No. 2" from the parent Inekogane cells (Sumitomo Chemicals)

(Field of Animals)

(4) Gene Recombination Also Active in Japan

Since the creation of super mouse, transgenic mice containing various human genes, super pig, sheep that expresses blood coagulation gene in the mammary gland, recombinant sheep with increased wool production, etc., have been made in the United States, the United Kingdom, Australia, etc. In Japan, starting with shiner and mouse, a succession of transgenic animals have been made. Technology to infect an insect virus vector into silk worms for expression of the gene of a useful substance has also been developed.

- Creation of mice with the introduced type B hepatitis virus gene (Cancer Research Institute and National Institutes of Health).

- Shiner with the introduced luciferase gene (Frontier Technology Research Center, Tokyo University, and Toyo Suisan Kaishia).

• Mouse with the introduced gene of melanin producing enzyme (Tohoku University).

• Recombinant sheep with higher wool production (Adelaide University, Australia).

• Influenza vaccine production using silk worms (National Institutes of Health and Dai-ichi Seiyaku)

(5) Progress in the Development of Bovine Mass Reproduction Technology by Nuclei Transplants

The Granada Company of the United States has established the technology of increasing the number of fertilized eggs by introduction of the cells of fertilized eggs at the 32 cell stage into the nuclei of unfertilized eggs. By repeating this procedure, the reproduction number can be expected to increase step-wise to the second and third order of 32. In our country, the bovine embryo cells at the 16 cell stage have been successfully transplanted by cooperation between the National Institute of Animal Industry and Animal Industry Center of Chiba Prefecture, and progress from now on may be quite noticeable.

(Field of Food)

(6) Progress in the Elucidation and Practical Application of Functions of Food Components

Reflecting the heightened desire for health in recent years, the movement toward recognizing "functional food" by the Ministry of Health and Welfare [MHW], and the success of fiber containing liquid food in the market place, rapid progress is being made in the elucidation of health improving functions of food, and in the development and application of health improving food ingredients.

• Sugar substances: Production of, by bioreactors, "Parachinose" (Mitsui Sugar Co.), Fructooligo Sugar (Meijo Seika Kaisha), and Erythritol (National Food Research Institute and Japan Chemical Research Institute)

• Various health beverages containing food fibers, "kondroichin" sulfate, oligo sugars, etc.

• Development of a technology for selectively extracting catechin (Vegetable and Ornamental Crops Research Station, National Research Institute of Tea and Lotte Corp.)

• Healthy eggs effective in controlling cholesterol with eicosapentaenic acid supplement (Ise and Climson University)

(7) Progress in the Development of New Type Bioreactors

New type bioreactors, water dispersing filtration bed type and rotating column type that improve the reaction efficiencies, are being developed. In the water dispersing filtration bed type, the fermentation vessel is divided into the upper and lower parts. In the upper aerobic zone, multiplication of yeast cells takes place in the fog-like dispersion of fermentation fluid, and in the lower anaerobic zone, alcohol is rapidly produced. In the rotating column type, a column of wire mesh containing fixed enzyme or microorganism is rotated.

- Rotating column bioreactor (Snow Brand Milk Products Co.)

- Water dispersing filtration bed type (Nippon Gaishi, Morita)

(Others)

(8) Progress in the Development of Membrane Application Technology

Rapid progress is being made in the practical applications of separation technologies of various membranes, led by ultrafiltration membranes, in the fields of food and waste water treatment. In addition, the development of highly selective affinity membranes that utilize the affinities between substances and the development of biosensors that utilize high molecular weight membranes and various other membranes are in progress.

- Development of the system for recovering proteins and amino acids from waste water of sea food processing (Nippon Suisan Kaisha, Japan Organo Co., and Nitto Electric Industrial Co.)

- Production of the raw material for fermentation into glutamic acid from the wash solution of sugar with a functional membrane (Taito Co., Mitsui Sugar Co., Ajinomoto Co., and Mitsui Shipbuilding and Engineering Co.)

- Enzyme sensor using silk fibroin membrane (Tokyo University of Agriculture and Technology)

- Fructose sensor using an enzymatic reaction (Agency of Industrial Science and Technology [AIST])

- Alcohol sensor using fixed coenzyme (Tokyo Institute of Technology)

(9) Progress in the Applications of Biotechnology in the Field of Environment

Progress is being made in the development of technologies using microorganisms to decompose toxic substances, PCB, BHC, etc., that become soil polluting problems; of biodegradable plastics that can be decomposed by microbial enzymes; of freon substitutes in response to one of the global environmental problems; and of the technology of carbon dioxide fixation.

• Decomposition of soil polluting chemicals by utilization of microorganisms (National Institute for Environmental Studies, Canada National Science Research Institute, Tokyo University, and others).

• Conducting experiments in decomposition of toxic substances with microorganisms in the sea contaminated by oil spill (U.S. EPA)

• Detergent solutions containing high molecular weight oligo sugars from plants as the major ingredient as a substitute for freons (Sakata Engineering Co.)

• Development of carbon dioxide fixation technology using porphyrin complex (Tokyo University and others).

III. Status of Promotion at MAFF

III-1. Budgetary Measure for Biotechnology Related Affairs in FY 1990

The developments of biotechnology in the AFF and food industries are greatly expected to open the future for these industries through tremendous increase in their productivities. Because of this, various policies are being implemented and strengthened for the purpose of conducting research in basic and forefront areas with plans and emphases, and at the same time, strengthening the cooperation among industries, universities, and governmental agencies. Development of innovative technologies in various industrial fields, and large-scale research projects based on long-term views will be continuously promoted. The MAFF policy is to also facilitate practical applications of the results of these R&D.

In FY 1990, a total sum of about ¥7.9 billion is allocated for the purpose.

(Note) In the budget for biotechnology related affairs, aside from the experiment and research budget of the AFF Technology Conference Secretariat, the budgets of other agencies and bureaus for popularization of and awards for practical applications of biotechnology are included.

(Biotechnology Related Budget)

(Unit: ¥1 million)

Item	FY 89 budget	FY 90 budget	Remark
I. Promotion of R&D in frontier biotechnology of AFF and food industries	3,638		
1. Promotion of basic and forefront R&D aiming at 21st century, etc.	2,944		
	0		•Development of assessment techniques for introducing recombinant organisms into the ecosystem (new)
	417		•Comprehensive research in elucidation of order in AFF ecosystem and its most appropriate control
	477		•Comprehensive research in elucidation of biological information and development of new AFF technologies based on control of information (Biomedia Plan)
	103		•Comprehensive research in cultivation of seeds of frontier technologies of biotechnology (commissioned to universities)
	458		•Comprehensive research in applying biotechnology for plant breeding
	52		•Development of system of growing new hybrid in seedling industry (Assistance to private industry)
	47		•Research on development of bio-nursery system (Joint research with private industry)
	82		•Analysis of animal genes and development of application technology
	110		•Development of new beef cattle production technology based on multiple births by test tube insemination
	0		•Biotechnology breeding research included in specified research project
	258		•Promotion of regional biotechnology R&D (assistance to municipalities, regions, and prefectures)
	513		•Operation and administration of AFF gene bank

[continued]

[Continuation of Table]

Item	FY 89 budget	FY 90 budget	Remark
2. Promotion of projects in innovative technology related to food industry	638	726	
	0	89	•Alteration of food functions and development of advanced technology (new)
	0	121	•Development of technology based on elucidation of post harvest physiology for supplying high quality vegetables and fruits (new) (Joint research with private industry)
	139	134	•Development of high density large-scale food culture production system applying superhigh pressure
	103	100	•Development of enzyme function altering technology for food industry
	52	51	•Development of technology for applying improved biosynthesis system for increasing efficiency of agrichemical productions
	51	50	•Development of basic technology for utilization of biological activities for development of new fertilizers
	37	36	•Development of basic technology for practical applications of vaccines derived from genetic manipulations for insect induced diseases
	90	78	•Elucidation of activities in the rhizosphere environment and development of the controlling technology, etc.
	35	36	•Establishment of system of practical application of biotechnology using regional resources, etc.
3. Preparation of foundation for development and practical application of biotechnology	20	37	•Contribution to OECD international joint research (new)
4. Promotion of international exchange related to bio-technology research			•International joint research in development of forefront technologies, etc.

[continued]

[Continuation of Table]

Item	FY 89 budget	FY 90 budget	Remark
II. Promotion of large research projects with long-term view	1,551	1,411	
	0	142	•Elucidation of dynamic state of AFF ecosystem accompanying global environmental change and development of prediction technology (new)
	285	297	•Development of new types of rice flooded field crops for expanding demand (Super rice plan)
	406	377	•Comprehensive research in development of efficient technology for utilization of biological resources (Biomass conversion plant)
	349	356	•Development of high quality and high yield crops for increasing rice field utilization and development of highly stable production technology
	478	206	•Preparation and operation of Agriculture and Forestry Exchange Center, etc. (Preparation ended in FY 89)
III. Development and practical application of new technology	2,344	2,602	
1. Promotion of supply of superior seedlings derived from tissue cultures	450	474	•Within tasks of stabilizing and securing superior seeds and seedlings, part pertaining to tissue cultures, etc.
2. Promotion of practical application of new agricultural technology	227	208	•Survey and demonstration of production and distribution technology of functional food materials
3. Promotion of practical application of new technology for animal production	1,043	1,194	•Survey and collection of forefront technology, etc. •Preparation tasks for a fertilized egg supply center
4. Promotion of practical application of forefront technology in food industry	148	242	•Tasks in improving water treatment technology using microorganisms for food industry, etc. (new)

[continued]

[Continuation of Table]

Item	FY 89 budget	FY 90 budget	Remark
5. Development and practical application of new technology for wood processing and utilization	203	185	•Development of technology for prevention of red tide by marine biotechnology (new)
6. Development and practical application of new technology in fishery industry	273	299	•Development of technology for improving and diversifying usage of unused marine resources (Marine frontier project), etc.
Total	7,533	7,902	

Organizations for promoting industrial technologies specific to biological system (Industry investment special account)	3,400	3,500	Financing and loans for research in industrial technology specific to biological system
Japan Development Bank	4,000	4,000	Financing promotion of practical application of biotechnology
Hokkaido and Tohoku Development Corp.	300	300	Financing promotion of commercialization of regional biotechnology
Agriculture, Forestry and Fishery Finance Corp.	In-cluded in 18,400	In-cluded in 24,300	Financing the joint-use facilities for application of biotechnology
Fund for improving agriculture	100	100	Financing the facilities for growing virus-free seedlings

Note: Because of rounding, the total may not be identical to the sum of the individual items.

III-2. Promotion of Biotechnology by the National Government

1. Organizations Engaged in Various Research Projects

(1) Biotechnology Field

Project title	Participating organization (planned for consignment)	FY 90 budget (FY 89)	Effective period
Comprehensive research in elucidation of order in AFF ecosystem and its most appropriate control	Agriculture Research Center [ARC], National Institute of Agriculture Environment and Science [NIAES], National Institute of Animal Industry, National Grassland Research Institute, Fruit Tree Research Station, Vegetable and Tea Research Station, Hokkaido Agricultural Experiment Station [AES], Tohoku AES, Hokuriku AES, Chugoku AES, Kyushu AES, Silk Worm Research Institute, Research Institute of Domestic Hygiene, National Forestry Research Institute, Hokkaido Regional Fisheries Research Laboratory [RFRL], Tohoku RFRL, Central Fisheries Research Institute, Nanseikai RFRL, Nipponkai RFRL, Pelagic Fishing Research Laboratory, National Research Institute of Aquaculture, National Research Institute of Fisheries Engineering, Hokkaido Salmon and Trout Hatchery and College of Fishery (Yaiwate Prefectural Animal Industry Laboratory, Hokkaido U., Tohoku U., Tokyo U., Mie U., Kyoto U., Osaka U., Okayama U., Shimane U., Kochi U., Kyushu U., National Institute of Genetic Research, Tokai U., Kitasato U., Meiji U., and Marine Industries Research Association)	Millions of ¥ 426 (417)	FY 1989–1998
Comprehensive research in elucidation of biological information, development of new AFF technologies based on control of information	ARC, National Institute of Agrobiological Resources [NIABR], NIAES, National Institute of Animal Industry, Fruit Tree Research Station, Vegetables and Tea Research Station, Tohoku AES, Chugoku AES, Silk Worm Research Institute, Research Institute of Domestic Hygiene, National Food Research Institute, National Forestry Research Institute, Tohoku RFRL, [continued]	498 (462)	1988–1987

[Continuation of Table]

Project title	Participating organization (Planned for consignment)	FY 90 budget (FY 89)	Effective period
	Central Fisheries Research Institute, Nanseikai RFRL, National Institute of Aquaculture and College of Fishery (Tokoku U., Tsukuba U., Saitama U., Tokyo U., Tokyo Gakugei U., Tokyo U. of Agriculture and Technology, Osaka U., Kyoto U. of Industrial Art and Textile, Kobe U., Shimane U., Hiroshima U., Kagawa U., Kyushu U., Saga U., Okazaki National Joint Research Organization, Saitama Medical School, Kitasato U., and Nippon U.)		
Analysis of genes of animals and development of technologies for utilization	National Institute of Animal Industry, Silk Worm Research Institute, Research Institute of Domestic Hygiene, Central Fisheries Research Institute, Seikai RFRL, and National Institute of Aquaculture (Okazaki National Joint Research Organization and Kyoto University)	83 (82)	1989-1995
Development of new beef cattle production technologies based on multiple births by test tube insemination	ARC, National Institute of Animal Industry, National Grassland Research Institute, Hokkaido AES, Tohoku AES, Chugoku AES, Kyushu AES, and National Institute of Domestic Hygiene (Kitasato U. and Domestic Animal Improvement Technology Center of Association of Domestic Animal Improvement Industries)	112 (110)	1988-1992
Comprehensive research on applications of biotechnology in plant breeding	ARC, NIABR, NIAES, National Grassland Research Institute, Fruit Tree Research Station, Vegetable and Tea Research Station, Hokkaido AES, Tohoku AES, Chugoku AES, Shikoku AES, Kyushu AES, Silk Worm Research Institute, National Food Research Institute, Tropical Agriculture Research Center, National Forestry Research Institute, and Seikai RFRL (Tokyo U., Saitama U., Nagoya U., Kyoto U., Kyoto U. of Industrial Art and Textile, and Kyoto Prefectural U.)	460 (458)	1986-2000

[continued]

[Continuation of Table]

Project title	Participating organization (Planned for consignment)	FY 90 budget (FY 89)	Effective period
Research in elucidation of plant DNA base sequences	NIABR, NIAES, and Hokuriku AES (Tohoku U., Nagoya U., Kyushu U., and Tokyo Institute of Technology)	74 (81)	1987–1990
Development of methods for assessing introduction of recombinant organisms into ecosystem (new)	NIABR, NIAES, National Institute of Hygienic Science, National Food Research Institute, and National Forestry Research Institute (Hokkaido U., Tsukuba U., Tokyo Institute of Technology, Science U. of Tokyo, Imperial Kyoto U., Nippon Plant Disease Prevention Association, Takara Shuzo Co., Shimazu Seisakusho Ltd., Safety Research Laboratory of Mitsubishi Chemical Industries, Ltd., and Biosystem International)	91 (0)	1990–1992
Development of new technologies utilizing micro-organisms and enzymes for biomass conversion	National Institute of Animal Industry, National Food Research Institute, and National Forestry Research Institute (Tsukuba U., Nagoya U., Yiwate Prefectural Fermentation Food Research Station, Meiji Seika Kaisha, and Nippon Starch Industries)	66 (73)	1982–1990
Elucidation of activities in the rhizosphere environment and development of technology for their control	ARC, NIABR, NIAES, National Grassland Research Institute Fruit Tree Research Station, Vegetable and Tea Research Station, National Institute of Agricultural Engineering, Hokkaido AES, Tohoku AES, Chugoku AES, Shikoku AES, Kyushu AES, Silk Worm Research Institute, and National Forestry Research Institute (Ibaragi U., U. of Agriculture and Technology, Kyoto U., Yamaguchi U., Tokyo U. of Agriculture, and Toiguchi Biological Chemistry Research, Inc.)	78 (95)	1986–1990

[continued]

[Continuation of Table]

Project title	Participating organization (Planned for consignment)	FY 90 budget (FY 89)	Effective period
Research related to development of bio-nursery systems	ARC, NIABR, Fruit Tree Research Station, Vegetable and Tea Research Station, National Institute of Agricultural Engineering, Hokkaido AES, Shikodu AES, Silk Worm Research Institute, and 25 private companies	42 (47)	1987-1990
Development of technologies for supplying high quality vegetables and fruits based on elucidation of post-harvest physiology (new)	Fruit Tree Research Station, Vegetable and Tea Research Station, Hokkaido AES, Shikoku AES, National Agriculture Research Institute, and National Food Research Institute (Nagoya U. and Chiba Prefectural AES)	121 (0)	1990-1994

(2) Other Related Fields

Project title	Participating organization (Planned for consignment)	FY 90 budget (FY 89)	Effective period
Development of new types of rice paddy crops for expanding demand (Super Rice Project)	ARC, NIABR, Hokkaido AES, Tohoku AES, Hokuriku AES, Chugoku AES, Shikoku AES, Kyushu AES, National Food Research Institute, and Tropical Agriculture Research Center (Chiba U., U. of Agriculture and Technology, Nagoya U., Kyoritsu Women's U., Fukuyama U., Hokkaido Uekawa AES, Aoyama Prefecture AES, Miyagi Prefecture Furukawa AES, Niigata Prefecture Food Research Institute, Tomiyama Prefecture Agricultural Technology Center, Fukui Prefecture AES, Aichi Prefecture Agriculture Research Institute, Aichi Prefecture Food [continued]	Millions of ¥ 297 (285)	FY 1989-1995

[Continuation of Table]

Project title	Participating organization (Planned for consignment)	FY 90 budget (FY 89)	Effective period
	Technology Laboratory, Hiroshima Prefecture Food Technology Center, Miyagi Prefecture Agriculture Research Institute, Kagoshima Prefecture AES, Kameda Seika Co., Toyo Suisan Co., and Kikumasamune Shuzo Co.		
Comprehensive research in development of efficient technologies for utilization of biological resources (Biomass Conversion Plan)	NIABR, NIAES, National Institute of Animal Industry, National Grassland Research Institute, Hokkaido AES, Tohoku AES, Hokuriku AES, Kyushu AES, National Food Research Institute, National Forestry Research Institute, Hokkaido Regional RFRL, and Central Fisheries Research Institute (Hokkaido Region Central AES, Hokkaido Region Kitami AES, Hokkaido Region Forestry Experimental Station, Aomori Prefecture Animal Husbandry, Experimental Station, Yiwate Prefecture Forestry Experimental Station, Tomiyama Prefecture Lumber Experimental Station, Kagoshima Prefecture AES, Tohoku U., Tokyo U., U. of Agriculture and Technology, Ochanomizu Women's U., Shizuoka U., Kyoto U., Kagawa U., Kyushu U., Oji Paper Co., Hokkaido Developmental Problems Research and Survey Association, Inc., Kanezaki Co., Nikken Chemicals Co., and Mitsubishi Chemical Industries)	377 (406)	1981-1990
Development of high quality and high yield crops for increasing rice paddy utilization, and development of highly stable production technology	ARC, NIAES, National Institute of Animal Industry, National Grassland Research Institute, National Institute of Agricultural Engineering, Hokkaido AES, Tohoku AES, Hokuriku AES, Chugoku AES, Shikoku AES, Kyushu AES, and National Food Research Institute (Biology research Organizations, Spinshu U., Kyushu U., and Akita Prefecture Ogata Branch AES	356 (349)	1987-1996

[Continuation of Table]

Project title	Participating organization (Planned for consignment)	FY 90 budget (FY 89)	Effective period
Elucidation of dynamic state of AFF ecosystem accompanying global environmental change and development of predicting technology (new)	ARC, NIABR, NIAES, National Grassland Research Institute, Fruit Tree Research Station, Tohoku AES, Hokuriku AES, Kyushu AES, National Forestry Research Institute, Central Fisheries Research Institute, Nipponkai Region RFRL, and College of Fishery (Tohoku U., Tsukuba U., Tokyo U., Kyoto U., and Osaka Municipal U.)	142 (0)	1990-1995

2. The Content of Individual Research Project

(Biotechnology Field)

(1) Comprehensive Research in Elucidation of the Order in the AFF Ecosystem and the Most Appropriate Control (FY 89-98)

FY 90 Budget	(FY 89 Budget)
Millions of ¥	
426	(417)

1) Objectives

In the natural ecosystem, various living things maintain close mutual relationships while maintaining an overall order and harmony. This situation is called "ecological order."

As we face the 21st century, in order to have healthy AFF industries to supply various kinds of food and to secure long-term production fields, it is necessary for us to utilize various superior functions of the ecosystem intensively without damaging them, to manage AFF biological resources, and to develop production technologies and most appropriate control technologies for the production environment.

Therefore, specific survival strategies and adaptation styles of individuals, aggregates of individuals and groups that comprise the ecosystem at various levels will be studies to elucidate unknown important elements involved in interactions among living things and their functions.

2) Major Technology Development Projects

(a) Technologies for the control of the biological aspect of the agricultural ecosystem, and for a high level and stable production

a) Management technology for maintaining high level productivities of farmland and grassland vegetations.

- New weed prevention technology based on elucidation of interactions between the crop and weeds in farmland.

- Technology for maintaining stable grassland, based on elucidations of the ecological position of seeds and the ecological interactions such as allelopathy in semi-natural grassland.

b) Technologies for ecological prevention and utilization of agricultural insects.

- New technology for preventing harmful insects based on the elucidation and utilization of interacting ecological factors (pheromone, kairomone, etc.).

- New application technologies such as improving the pollination rate of fruit trees based on the elucidation and control of the characteristic actions of pollination mediating insects.

c) New management technology for grazing animals, based on the elucidation of movement controlling factors such as smell, voice, etc.

(b) Stable production of forest products from natural forests and forest ecosystem conservation technologies

a) Technology to promote conversion of low utility natural forests into useful deciduous forests based on the elucidation of the transfer mechanism of forest vegetation.

b) Technology for maintaining stable useful deciduous forests based on the elucidation of reproductive mechanism of useful deciduous trees.

(c) Technologies for predicting changes in fishery resources and for stable long-term productions

a) Technology for highly accurate prediction of the movement of floating fish such as pilchard based on elucidation of its initial decrease and reproductive mechanisms.

b) Technology for increasing useful ocean bottom resources such as halibut based on the elucidation of its inclusion and settlement mechanisms in the ecosystem.

c) Technologies for increasing the resources and productivities of rivers based on the elucidation of the mechanism of returning and the mechanisms by which a group of sockeye salmon determines the direction and the group recognition.

(2) Comprehensive Research in Elucidation of Biological Information and Development of New AFF Technologies by Controlling This Information (FY 88-97)

Millions of ¥
498 (462)

1) Objectives

To elucidate the mechanisms of information transmissions and recognitions involved in the expressions of biological functions inside biological bodies at the molecular levels of hormone, enzymes, etc.; and to develop new production management technologies for crops and domestic animals, technologies for stable production of marine animals and superior seedlings, and new production technologies for the biology related industries by the most appropriate controls of these information transmissions and recognitions so that the potential or undeveloped functions of living things may be utilized to the utmost limit.

2) Major Technology Development Projects

(a) Development of new technologies for crop production management

- Development of technologies for controlling growth and differentiation.
- Development of cultivation technologies under poor conditions.
- Development of high-yield cultivation technologies based on the new symbiotic production or improvement in the symbiosis.
- Development of technologies to bolster or to reform the functions of invertebrates.
- Development of new technologies to control invertebrates.

(b) Development of new management technologies for production of domestic animals

- Development of technologies for controlling infections and disease incidences.
- Development of technologies for increasing and controlling reproduction and milk production.

(c) Development of technologies for stable production of superior stocks of marine animals

- Development of technologies for stable productions of superior marine animals by the control of egg productions.

- Development of technologies for stable productions of shell fishes by fortiying their biological defense mechanisms.

(d) Development of new production technologies for industries in biology related areas

- Development of innovative manufacturing processes.

- Development of technologies to imitate living things.

- Development of production technologies of new useful substances.

(3) Analyses of Genes of Animals and Development of Technologies for Their Utilization (FY 89-95)

Millions of ¥
83 (82)

1) Objectives

The main target is to apply genetic engineering that has seen astonishing progress in recent years to the areas of animals. The structures of genes of animals will be analyzed and the control mechanisms of their expressions will be elucidated.

Furthermore, the results of gene analyses will be utilized for the development of technologies for mass production of useful substances such as physiologically active substances and technologies for producing new breeding materials.

2) Major Technology Development Projects

(a) Elucidation of the structures and functions of useful genes

Isolation and structural analysis of useful genes such as insect fibroin, swine interferon, etc., will be conducted, and the regulating mechanism of the gene expression will also be elucidated.

(b) Development of genetic engineering technologies for utilization of useful functions

The technology to insert a gene into the cell culture of bovine leucocyte or other cells will be developed to make possible mass production of hormone, vaccine or other useful substances. Also, the technology to insert a new phenotype gene into the egg of rainbow trout will be developed in an attempt to produce the phenotype stock of a new variety.

(4) Development of New Beef Cattle Production Technologies Based on Multiple Births by Test-Tube Insemination (FY 88-92)

Millions of ¥
112 (110)

1) Objectives

The demand for beef is projected to increase. In Response to this, and to lower the production cost and to produce beef cattle accurately reflecting the consumption trend, technology for producing low cost fattened beef cattle, centering on the multiple births technology of test-tube insemination that uses no rabbit oviduct in combination with technology for efficient raising, will be developed.

2) Major Technology Development Projects

(a) Development of technologies to increase the number of calves by embryo manipulation, etc.

(b) Development of technologies for raising fattened beef cattle by high level nutrition and health management.

(c) Development of technologies for raising fattened beef cattle by intensive grazing.

(d) Managerial evaluation of new technologies for fattened beef cattle production.

(5) Comprehensive Research on Applications of Biotechnology in Plant Breeding (FY86-2000)

Millions of ¥
460 (458)

1) Objectives

Plant breeding is the backbone of AFF technology development. It has played the central role in the productivity increase of AFF industries, expanding the demand of AFF products.

As the basic undertone of demand and supply of food are projected to grow even more tense for middle to long term, cultivation of superior varieties and production of new useful plants that respond to the needs of production, consumption, and demand are urgent projects of the development of AFF production technologies. Included are stable and high yielding varieties, varieties highly resistant to diseases and insects, highly nutritious and good tasting high quality varieties, etc.

With the development of biotechnologies of cell fusion, DNA recombination, etc., various basic technologies such as utilization of genes which could not be utilized by the past breeding technology, shortening of the breeding time, etc., have become available. The outlooks are good for growing unprecedented new varieties or producing new useful plants.

Because of this, along with expansion and preparation of the AFF gene bank, a comprehensive development project in plant breeding, using the forefront technologies of biotechnology such as cell fusion, DNA recombination, etc., has begun. The objectives of the project are to attain the definite breeding targets of wheat varieties highly resistant to humidity for the purpose of high utilization of rice field, high protein (high lysine) rice, virus-resistant vegetables, rice varieties with high photosynthesis capacity, etc., by the year 2000.

2) Major Technology Development Projects

(a) Development of common basic technologies

The common basic biotechnological technologies for the production of breeding materials and for the efficient growing of plant varieties will be developed.

- Development of cell manipulation technology

  Methods for efficient cultures of isolated and fused cells, re-differentiation technology, methods for early selections of properties such as resistance to poor growing conditions, disease resistance, etc., at the cellular level will be developed.

- Development of DNA manipulation technology

  Development of technologies for the isolations, identifications, and structural analyses of useful genes; development of vectors; development of the method for inserting the gene into plant cells; elucidation of the expression mechanism of the inserted gene; etc., are conducted.

(b) Applying biotechnology to produce new breeding materials

The definite aims of breeding will be decided and the new breeding materials produced by applying biotechnology.

- On breeding highly resistant varieties, unprecedented new breeding materials possessing high levels of resistance to insects and the environment will be produced.

- On breeding varieties with specific compositions, unprecedented new breeding materials with high contents of useful components such as protein, etc., will be produced.

- On breeding varieties possessing new functions, new breeding materials having high photosynthesis function, etc., will be produced, utilizing the features of biotechnological breeding techniques to the utmost.

(c) Cultivation of unprecedented new varieties and creation of new useful plants

The breeding materials produced by the R&D in ii above will be used for cultivations of unprecedented new varieties of major agricultural crops and for creations of new useful plants.

(6) Research in Elucidation of Plant DNA Base Sequences (FY 87-90)

Millions of ¥
74 (81)

1) Objectives

In order to produce unprecedented new varieties by DNA recombination technology, it is necessary to understand plant genes that act in a variety of ways.

However, in plant genes, the following problems exist:

(a) More than one gene is involved in one function.

(b) The quantities of enzyme proteins that control the expression of a function are minute, making their purification difficult in many cases.

(c) For understanding regulation genes, the commonly used characterization method of protein amino acid sequencing is not applicable.

To solve the above problems, it has been proposed that the genes be characterized by the information on the base sequences of the DNA's of the subject plant. In this research, various techniques for the efficient elucidation of plant DNA base sequences will be developed.

2) Major Technology Development Projects

(a) Isolation and partition of chromosomes

- Synchronized culture method for obtaining a large quantity of chromosomes at a specific mitotic phase will be developed. Techniques for identifying and partitioning various chromosomes will also be developed.

(b) Preparation of gene maps

- Marker genes will be isolated, and gene maps will be prepared based on the structural analysis and RFLP analysis.

(c) Efficient base sequence determination and deciphering system

- Efficient analytical systems for the analysis of chromosomal fine structures by image analysis and for handling a large quantity of the base sequence data will be developed.

(7) Development of Methods for Assessing Introduction of Recombinant Organisms Into the Ecosystem (New) (FY 90-92)

Millions of ¥
91 (0)

1) Objectives

As biotechnology has progressed to the point of necessitating field tests of various recombinant organisms, the methods for assessing their environmental impacts need to be established. To be developed are high speed and high sensitivity detection methods using the forefront molecular biology techniques, the assessment method for evaluating the effects of introduced genes on the ecosystem, the management method for assuring the safety of recombinant organisms, etc.

2) Major Technology Development Projects

(a) Development of high speed and high sensitivity methods for the detections of recombinant organisms.

(b) Evaluation of the effects of the introduced gene on the ecosystem.

(c) Facile identifications of important affected items.

(d) Development of the management technique for assuring the safety of an open system.

(e) Development of the assessment method for introduction of recombinant organisms into the ecosystem.

(8) Development of New Technologies Utilizing Microorganisms and Enzymes for Biomass Conversion (FY 82-90)

Millions of ¥
66 (73)

1) Objectives

For efficiently converting biomass resources (reproducible unused biological resources and new biological resources) into food, feed, energy, etc., microorganisms and enzymes that are highly active and possessing new functions will be sought and improved, and mass production technologies and fixation technologies of useful microorganisms and enzymes will be developed to help establish new microorganism and enzyme application technologies.

2) Major Technology Development Projects

(a) Microorganisms and enzymes that will efficiently decompose and convert insoluble and hard to decompose resources such as untreated starch, cellulose, etc., will be sought and improved.

(b) Development of efficient mass production technologies and fixation technologies of useful microorganisms and enzymes.

(c) Development of highly efficient, multiple stage bioreactors for insoluble and hard to decompose resources.

(d) Development of composite enzyme sensors for the purpose of measuring and controlling the reactions inside a bioreactor.

(9) Elucidation of Activities in the Rhizosphere Environment and Development of Technology for Their Control (FY 86-90)

Millions of ¥
78 (95)

1) Objectives

In order to maintain and upgrade the productivity of the land and thereby to stabilize and increase crop productions, the interactions among crop roots, soil microorganisms and soil will be elucidated and technologies for controlling the rhizosphere environment will be developed by applying the functions of soil microorganisms, biotechnology, and other new techniques.

2) Major Technology Development Projects

(a) Elucidation of the dynamic state of rhizosphere environment

- Elucidations of the dynamic state and antagonist mechanisms, and evaluation of the functions from the viewpoint of bioreactors.

(b) Elucidation of the interaction between the growth of the crop and the rhizosphere environment

- Development of the methods for investigating the dynamic state of the crop roots, elucidation of the functions of the substances secreted from the crop roots, elucidation of interactions among the rhizosphere environment, the crop roots, and above ground stress, etc.

(c) Development of the technologies for controlling the rhizosphere environment

- Development of comprehensive diagnostic technologies for appraising the suitability of rhizosphere environment for crop cultivation.

- Development of technologies for improving microorganisms by cell fusion, phenotype transfer, etc., and development of technologies for fixing the cells of useful microorganisms for bolstering their bioreactors' functions.

(10) Research Related to Development of Bio-Nursery Systems (FY 87-90)

Millions of ¥
42 (47)

1) Objectives

Stabilization of somatic, embryonic, and other cells for large-scale applications of test-tube plant culture technology.

- Development of large-scale propagation methods and technologies for growing seedlings and their acclimation. Also, development of technologies to add values, such as conferring resistance, etc., to the seedlings and designing these into a system.

  Also, joint research with private enterprises in order to put the accumulated research capital of enterprises into good use.

2) Major Technology Development Projects

(a) Development of technologies to convert plant cultures into seedlings

- Technologies for induction and propagation of somatic cell embryos, etc.
- Technology to promote growth of emerging plant cultures.
- Technology to acclimate emerging plant cultures.

(b) Development of technologies to condition emerging seedlings into stabilized seedlings.

- Elucidation of factors involved in rapid stabilization of seedlings and development of the technology to control them.
- Soft technology for the bio-nursery system.
- Equipment and facilities for rapid, large-scale production of high quality seedlings.

(c) Development of technologies to increase the added values of seedlings

- Technology for controlling growth by plant growth regulating chemicals.
- Technology for efficient management of useful microorganisms.

(11) Development of Technologies for Supplying High Quality Vegetables and Fruits Based on the Elucidation of Post-Harvest Physiology (New) (FY 90-94)

Millions of ¥
121 (0)

1) Objectives

Along with the change in the lifestyle of people, the supplies of agricultural products are required to adjust to diversification in distribution and mode of consumption. Particularly for vegetables and fruits, whose qualities drop drastically after the harvest, it is important to supply high quality vegetables and fruits in response to the requirement of consumers and food industry.

As the change in the qualities of agricultural products is based on physiological phenomena, development of the technologies will be based on the elucidation of physiological mechanisms.

2) Major Research Projects

(a) The needs of consumers and food industry will be analyzed, and suitable parameters (taste, texture, smell, etc.) for raw and processed foods in response to these needs will be selected.

(b) The change in these elements after the harvest and during the storage will be elucidated from the standpoint of enzymes and genes.

(c) The technologies to improve the quality at individual stages of distribution, storage, and cultivation will be developed based on these knowledges.

<Other Related Fields>

(1) Development of New Types of Rice Paddies Crops for Expanding Demand (Super Rice Project) (Reorganized New Project) (FY 89-95)

Millions of ¥
297 (285)

1) Objectives

Research that will help expanding the demand for rice: cultivation of varieties of rice with new characteristics such as jumbo rice, fragrant rice, superbly tasty rice, etc.; development of processing and application technologies for adding values; development of high yield varieties; etc., will be conducted.

2) Major Technology Development Projects

(a) Development of new breeding technologies

Breeding will be made more efficient by searching for and developing the technology for applying the gene(s) that will increase the grain yield of the cross between a Japanese type rice and an Indian type rice, developing new asexual propagation methods that require no seeds production by pollination, etc.

(b) Elucidation of properties of new phenotypes and development of new breeding materials

Physical properties such as viscosity, elasticity, etc., of new phenotype materials; and chemical properties of major constituents such as starch, lipid, etc., and minor constituents such as inorganic constituents, pigments, fragrant constituents, etc., will be elucidated. New breeding materials having these properties will be developed.

(c) Cultivation and evaluation of the properties of new varieties with high yield and suitability to the region

New varieties with extremely good palatability and high yield will be grown and their growth characteristics, evaluated.

(d) Development of technologies for utilizations of new varieties deriving from new phenotype lines

Technologies for processing and utilizing new varieties derived from new phenotype lines and varieties that can become the unique product of the region will be developed.

(2) Comprehensive Research in Development of Efficient Technologies for Utilization of Biological Resources (Biomass Conversion Plan) (FY 81-90)

Millions of ¥
377 (406)

1) Objectives

The aim is to convert and utilize comprehensively unused but reproducible biological resources and new production resources into food, feed, chemicals, energy, etc. Efficient, high yielding harvesting technology; energy saving recovery and transportation technologies; technologies for highly efficient decomposition, extraction, and conversion; etc., will be developed. Also developed will be regional composite utilization systems that are in harmony with the ecosystem.

2) Major Technology Development Projects

(a) Technologies for large-scale cultivations of biomass resources such as sweet sorghum, ipomea, sunflower, poplar, canba, giant seaweeds, etc.

(b) Technologies for efficient harvesting and transportation of woody resources.

(c) Technologies for efficient conversions of woody resources into raw materials by treatment with microorganisms and enzymes.

(d) Technology for converting woody resources into feed roughage by treatment with steam.

(e) Technologies for efficient extraction, isolation, and utilization of useful constituents from agricultural resources, woody resources, etc.

(f) Technologies for concentration and dehydration of dilute constituents by utilization of various membranes.

(3) Development of High Quality and High Yield Crops for Increasing Rice Paddies Utilization and Development of Highly Capable Production Technology (FY 87-96)

Millions of ¥
356 (349)

1) Objectives

Protection of rice farmers is the most urgent task of agriculture policy at present. Technological tasks for achieving this are increasing the qualities and yields of products such as wheat, soybean, feed, etc.; greatly lowering the production cost through rotating rice with other crops; etc.

The present project is in response to this demand; it is to help promote smooth enactment of the policy. New varieties of crops having unprecedented high quality and high yield are to be developed. Technologies for raising productivities of rice and rotating crops will also be developed.

Comprehensive technologies for establishing systems of methods of rotating crops with rice, wheat, and soybean as the main bases will be developed for various regions.

2) Major Technology Development Projects

(a) Development of technologies for intensive utilization of rice field

- Development of technologies for increasing the productivity of general purpose rice field.
- Development of technologies to increase the quality and new usage of crops.

- Development of technologies for production and distribution of feed products derived from introduction of new crops.

(b) Development of basic technology for ultra low cost production of rice

- Development of cultivation technology using ultra energy saving machines.

- Development of highly stable rice production technology based on knowledge and informations.

(c) Cultivation of high quality and high yield varieties

- Development of methods for evaluating the quality of farm products.

- Cultivation of high quality and high yield farm products.

(d) Establishment of a stable, high profit farm management system for a general purpose rice field

- Establishment of a highly stable production system for a general purpose rice field.

- Preparation of manuals for regional rotational crops farming technologies.

(4) Elucidation of the Dynamic State of AFF Ecosystem Accompanying Global Environmental Change and Development of Predicting Technology (New) (FY 90-95)

Millions of ¥
142 (0)

1) Objectives

The effect of regional environmental change goes beyond the confine of the region and is linked globally. The dynamic stated of AFF ecological system in connection with global environmental change will be elucidated. Technologies to predict the change in the quantities and areas of productions of AFF products will be developed, and predictions will be made to help develop the responding technologies.

2) Major Technology Development Projects

(a) Comprehensive analysis of changes in AFF productions induced by global environmental change

The effects of global environmental change on AFF productions will be analyzed and evaluated using the existing data of Japan and other countries.

(b) Elucidation of the dynamic state of carbon dioxide gas in the AFF ecosystem

The effect of environmental change on the carbon dioxide balance will be analyzed with quantitative analysis of generation and absorption of carbon dioxide in the AFF ecosystem. The dynamic state of carbon dioxide at the interface between the atmosphere and the earth surface, etc., will be elucidated.

(c) Elucidation of the dynamic state of the AFF ecosystem concomitant with environmental change

Genetically transferable, multiple changes in AFF products accompanying environmental change will be studied at various levels of varietal aggregates, individuals, proteins, and genes. At the same time, the changes in reproduction and growth, the environment of soil and the condition of sea induced by environmental change will be studied with the experiments conducted under a controlled environment to obtain the knowledge needed for high accuracy prediction.

(d) Development of the technology for predicting changes in the AFF ecosystem induced by environmental change

Technologies for predicting changes in the production of major grain crops, etc., will be developed to reveal the change in the quantities and production areas of AFF products of Japan and the world.

III-3. Promotion of Regional Biotechnology R&D, Etc.

1. Assisting R&D in Municipalities, Regions, and Prefectures

(1) Strengthening Biotechnological Breeding Within Designated Breeding Experimental Projects

FY 90 Budget	(FY 89 Budget)
Millions of ¥	
426	(417)

1) Objectives

Within the designated research projects consigned to appropriate prefectural experimental research organizations to carry out as a link of the national experimental research, biotechnological breeding techniques will be introduced and strengthened in order to promote accelerated development of superior varieties. In biotechnological breeding, genetic resources are more efficiently utilized and the time required to breed a variety in the breeding research is shortened.

2) The Scope of Strengthening in FY 90

- Shortening the breeding time using anther culture, etc., (rice, wheat, and vegetables).
- Breeding varietal seedlings using anther culture (tea).
- Breeding new varieties using embryo culture, young ear culture, etc. (grape, cherry, tulip and pasture grass).
- Breeding new varieties by cell fusion (soy bean, potato, pasture grass, and loquat).
- Preservation of genetic resources by cell and tissue cultures, etc. (lily).

(2) Promotion of Regional Biotechnology R&D

Millions of ¥
261 (258)

Technologies for improving and utilizing regional biological resources will be developed by the joint research of municipal, regional, prefectural, and other research organizations in coordination with national regional AES, etc., using biotechnological techniques.

1) Objectives

The aim is to promote technological developments of those important and possibly applicable basic research results which are being obtained at national research institutes. It will be based on the guidance and preparation at the national level. Joint researches will be conducted with municipalities, regions and prefectures with high research capability. Cooperation from universities will be obtained as needed. It will help elevate the level and expand the potential of regional biotechnology research.

2) Projects in Effect in FY 90 and Participating Organizations

Project title	Participating organizations
(Agriculture Industry Related) 1. Development of technologies for applications of embryo parts and emerging seedlings (FY 86-90)	NIABR; Vegetable and Tea Research Station; Hokuriku AES; Chugoku AES; Shikoku AES; Fukushima, Niigata, Fukui, Gunma, Aichi, Mie, Tottori, Shimane, Kochi, and Saga Prefectures.
2. Development of technologies for characterization and selection at the level of young plant culture (FY 86-90)	ARC, NIABR, Tohoku AES, Hokuriku AES, Chugoku AES, and Kyushu AES. Aomori, Akita, Yamanishi, Ibaragi, Gifu, Hyogo, Wakayama, and Miyagi Prefectures.
3. Development of technologies for improving regionally promoted products by cell fusion (FY 86-90)	ARC, NIABR, Vegetable and Tea Research Station, Hokkaido AES, and Kyushu AES. Ishikawa, Nagano, Shizuoka, Okayama, and Nagasaki Prefectures.
4. Development of technology for increasing the reproduction potential of cattle by twin birth (FY 86-90)	National Institute of Animal Industry [NIAI], Tohoku AES, Chugoku AES. Hokkaido, Yiwate, Shiga, Tokushima, Kumamoto, and Kagoshima Prefectures.
5. Development of technologies for increasing utilization of regionally unique products by using microorganisms, etc., in processing (FY 86-90)	NIABR and National Food Research Institute [NFRI]. Toyama, Hiroshima, Kagawa, and Fukuoka Prefectures.
6. Production of weak viruses appropriate for the regional conditions and establishment of prevention technology using these viruses (FY 86-90)	ARC, NIAES, Fruit Tree Research Station, Tohoku AES, Shikoku AES, and Kyushu AES. Hokkaido, Miyagi, Yamagata, Tochigi, Saitama, Yamaguchi, Aihime, and Okinawa Prefectures.
7. Development of technology for exterminating major disease causing insects of the region using microorganisms (FY 87-91)	ARC, NIAES, Chugoku AES. Iwate, Tomiyama, Chiba, Kanagawa, Kyoto, Kagawa, and Oita Prefectures.

[continued]

[Continuation of Table]

Project title	Participating organizations
(Forestry Industry Related) 1. Development of technology for propagation of superior plants by tissue culture (FY 86-90)	National Forestry Research Institute. Gifu, Mie, Hiroshima, Kumamoto, Oita, and Miyazaki Prefectures.
2. Production of superior varieties of edible mushrooms by cell fusion (FY 86-90)	National Forestry Research Institute. Ishikawa, Ibaragi, Tochigi, Nagano, and Shizuoka Prefectures.
3. Development of technology for cultivation of mushrooms having edible mycorrhiza (FY 86-90)	National Forestry Research Institute. Iwate, Fukushima, Shiga, Kyoto, and Nara Prefectures.
(Fishery Industry Related) 1. Production of new varieties of seaweed suitable for the region by development of protoplast seedlings (FY 86-90)	Seikai RFRL. Fukushima, Saga, and Aichi Prefectures.
2. Development of technology for production of large fishes by the establishment of sterilizing technology and technology for extending the reproductive life (FY 86-90)	Tohoku RFRL, Nippon Kai RFRL, Tokai RFRL, and Seikai RFRL. Aomori, Miyagi, Yamagata, Toyama, Ishikawa, Nagano, Gifu, Shiga, Tottori, Yamaguchi, Tokushima, Fukuoka, Nagasaki, and Kumamoto Prefectures.
3. Development of technology for production of high value fishes by establishment of sex control technology (FY 86-90)	
4. Development of technology for production of large clams by establishment of sterilizing technology and technology for extending the reproductive life (FY 86-90)	Tohoku RFRL and Nansei RFRL. Aihime Prefecture.

2. Assistance in Promoting Popularization in Municipalities, Regions, and Prefectures

(1) Promotion of Supply of Superior Seedlings From Tissue Cultures

Millions of ¥
474 (450)

Production, propagation, and preparation of the supply system of superior seedlings such as virus-free seedlings, etc., obtained from the application of biotechnology are planned in the following projects.

Task title	Task executing entity
Task to formulate the measures needed for high efficiency propagation and supply of superior vegetable seedlings	Municipalities, regions, prefectures, Keidanren, cities, towns, villages, agriculture cooperatives, etc.
Task to secure stable superior seedlings of potato family	Municipalities, prefectures, agriculture cooperatives, etc.
Task to renew fruit varieties, etc.	Regions, prefectures, agriculture cooperative association, etc.
Task to provide the production facilities for superior seedlings of flowering plants	Municipalities, cities, towns, villages, association of agriculture cooperatives, federation of agriculture cooperative associations, etc.

(2) Promotion of Application of New Animal Industry Technologies

Millions of ¥
1,194 (1,043)

Preparation of a system of promoting application of new animal industry technologies and other tasks involved in the application and promotion are being carried out. One of these is the "Fertilized Egg Supply Center Preparation Project (new)" which is to prepare the base for definitive popularization of fertilized egg transplant technology which is expected to become a powerful method for the realization of low cost beef production.

Task title	Task executing entity
Task to prepare fertilized supply centers	Municipalities, regions, prefectures, agriculture cooperative association, public corporations, etc.
Task to ensure practical application of fertilized egg transplant	Municipalities, regions, and prefectures.
Task to formulate special measures for the promotion of practical application of new animal industry technologies	Livestock improvement industry association, livestock fertilized egg transplant technology research association, agriculture cooperative associations, etc.
Among the tasks of popularizing new technological development in beef cattle production, nurturing the beef cattle propagation model base (utilization of new technologies), etc.	Agriculture cooperative association, federation of agriculture cooperative associations, public corporations, etc. Municipalities, cities, towns, villages, association of agriculture cooperatives, federation of agriculture cooperative associations, etc.

3. Organizational Involvement in Individual Regions

(1) Establishment of Systems for Applying Biotechnology in the Utilization of Regional Resources

Millions of ¥
10 (10)

Efficient R&D in biotechnology and its applications are promoted by utilizing the region's technological developmental potential and its various biological resources. The survey research on increasing the regional economic activity is carried out to discern the direction for promoting technological development.

(2) Status of Activities of Regional Biotechnology Related Organizations, Etc.

Since 1984, regional information exchange has been promoted by holding the periodical regional biotechnology conference in the seven regions of the nation, centering in the regional agricultural administration bureau and regional AES.

Based on the result of these activities, Tohoku, Kinki, and Kyushu regions have established permanent organizations such as research associations, to engage in such activities as publication of information magazines, conducting

and introducing technology research, and acting as intermediaries in joint research of industry, universities and governmental agencies, in addition to holding conferences.

1) Tohoku Regional AFF and Food Biotechnology Research Association (Organized in 24 March 1988)

(a) Objectives

The aim is to promote facile R&D and industrialization of biotechnology in AFF and related industries such as food industry to help develop the region's economy.

(b) Members

Enterprises and associations:	Enterprises and associations in AFF industries and other related industries such as food industry that are involved in biotechnology.
Research organizations:	Universities, laboratories, research organizations, etc.
Governmental agencies:	Individual prefectures, Tohoku Agricultural Administration Bureau, etc.

(Note) Membership: 233 (as of 16 March 1990)

(c) Major tasks

a) Collecting and furnishing various informations related to biotechnology (holding symposia and mailing research data (monthly), publishing bulletins (quarterly), etc.)

b) Furnishing the information on research trainee acceptance by research organizations and acting as the intermediary.

c) Acting as intermediaries and presentors of technological instructions, etc.

(d) Administration, etc.

a) Officers—President: Yasuyoshi Hiuga (professor, Faculty of Agriculture, Tohoku University)

Secretaries—4; Director, 1.

b) Business Office: Sendai Branch Office, AFF Finance Bank.

(e) Status of Tohoku Regional Biotechnology Conference, etc.

a) Composition, etc.

	Sponsor (business office)	Composition
Tohoku Regional Biotechnology Conference	Tohoku Agriculture Administration Bureau (Planning Coordination Office, but the division conference is sponsored by the Production Distribution Department) Tohoku AES.	National government, universities, prefectures, agriculture associations, private enterprises, etc.
Animal Industry Division Meeting	NIABR organizations (from FY 87)	
Seedling Division Meeting	Tohoku Region AFF Industries and Food Industry Research Association (from March 1988)	
Food Industry Division Meeting		

b) Status of meetings

	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89
Conference	1	1	1	1	1	1
Division meeting	3	2	3	2	3	3
Others	0	0	1	1	0	0

(Note) Until FY 87, Tohoku Agricultural Administration Bureau had been the main sponsor.

2) Kanto Regional Biotechnology Conference

(a) Composition, etc.

	Sponsor (business office)	Composition
Kanto Region Biotechnology Conference	Kanto Agricultural Administration Bureau (Agricultural Extension Division, Production Distribution Department).	National government, Municipalities, prefectures (administration and research), agriculture associations, private enterprises, etc.)
First Division Meeting (Plants)		
Second Division Meeting (Animals)	ARC. NiABR organizations.	
Third Division Meeting (Microorganisms, enzymes)		

(b) Status of meetings

	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89
Conference	1	1	1	1	1	1
Division meeting	0	0	0	0	0	0
Others	0	0	0	0	0	0

3) Hokuriku Regional Biotechnology Conference

(a) Composition, etc.

	Sponsor (business office)	Composition
Hokuriku Region Biotechnology Conference Animal Industry Division Meeting Food Industry Division Meeting Plant Breeding Division Meeting	Hokuriku Agriculture Administration Bureau (Agricultural Extension Division, Production Distribution Department). Hokuriku AES. NIABR organizations.	National government, universities, prefectures (administration and research), agriculture associations, private enterprises, etc.

(b) Status of meetings

	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89
Conference	1	0	0	0	0	0
Division meeting	0	2	1	1	1	2
Others	0	0	0	0	0	0

4) Biotechnology Tokai Regional Conference

(a) Composition, etc.

	Sponsor (business office)	Composition
Biotechnology Tokai Region Conference Product Division Meeting Food Division Meeting Animal Industry Division Meeting	Tokai Agricultural Administration Bureau (Agricultural Extension Division, Production Distribution Department). ARC. NIABR organizations.	National government, universities, prefectures, agriculture associations, private enterprises, etc.

(b) Status of meetings

	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89
Conference	1	2	1	1	1	1
Division meeting	0	0	0	0	0	0
Others	0	0	0	0	0	0

5) Kinki Region AFF and Food Biotechnology and Other Frontier Technology Research Promotion Conference (abbreviated as Kinki Biotechnology Promotion Conference) (Commenced on 24 May 1989)

(a) Objectives

Cooperation among governmental agencies, universities and industry to promote information exchanges and R&D in biotechnology and other forefront and advanced technologies.

(b) Members

Enterprises and associations: Enterprises and associations involved in biotechnology in the areas of AFF and related industries such as food industries.

Research organizations: Universities, laboratories, research organizations, etc.

Governmental agencies: Prefectures in Kinki Region, Kinki Agricultural Administration Bureau, etc.

(Note) Membership 236 (as of 25 May 1990)

(c) Major tasks

a) Publication and distribution of magazines providing information on forefront and advanced technologies.

b) Holding lectures on forefront and advanced technologies.

c) Providing information on joint research projects between national and other public research institutions and private enterprises.

d) Presentation of technical instructions by universities, national and other public research organizations.

e) Providing information on the investment fund needed for commercialization of forefront and advanced technologies.

f) Presenting information on genetic resources.

(d) Administration, etc.

a) Officers—President: Minoru Nakashima (professor emeritus, Kyoto University)

Vice-presidents: 3

Secretaries, directors, etc.

b) Business Office: Kinki Branch Office, AFF Finance Bank

(e) State of affairs of Kinki Biotechnology Conference, etc.

a) Composition, etc.

	Sponsor (business office)	Composition
Kinki Region Biotechnology Conference	Kinki Agricultural Administration Bureau (Agricultural Extension Division, Production Distribution Department). Chugoku AES. NIABR organizations (from FY 88). Kinki Region AFF and Food Biotechnology and Other Forefront Technologies Research Promotion Conference (from May 1989)	National government, universities, prefectures, agriculture associations, private enterprises, etc.

b) Status of meetings

	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89
Conference	1	1	1	1	1	0
Division meeting	0	0	0	0	0	0
Symposium	0	0	0	0	0	3
Lecture	0	0	0	0	0	1

(Note) Until 1988, Kinki Agricultural Administration Bureau had been the main sponsor.

(6) Chugoku/Shikoku Regions Biotechnology Conference

(a) Composition, etc.

	Sponsor (business office)	Composition
Chugoku/ Shikoku Regions Biotechnology Conference	Chugoku/Shikoku Agricultural Administration Bureau (Agricultural Extension Division, Production Distribution Department). Chugoku AES. Shikoku AES. NIABR organizations (from FY 88).	National government, universities, prefectures, agriculture associations, private enterprises, etc.

(b) Status of meetings

	FY 85	FY 86	FY 87	FY 88	FY 89
Conference	1	2	1	0	1
Division meeting	0	0	0	0	0
Others	0	0	0	0	0

(7) Kyushu Biotechnology Research Association (Commenced on 28 November 1989)

(a) Objectives

The aim is to promote biotechnology in the areas of AFF industries and food industry to help foster regional biotechnology R&D and AFF industries, food industry, etc.

(b) Members

Enterprises and associations:	Enterprises and associations involved in biotechnology in AFF industries, food industry and other related industries.
Research organizations:	Universities, laboratories, and research organizations.
Governmental agencies:	Prefectures in Kyushu region, Okinawa Prefecture, Kyushu Agricultural Administration Bureau, etc.

(Note) Membership 261 (as of 31 May 1990)

(c) Content of Major Tasks

a) Collecting and providing information on biotechnology.

b) Conducting research on the technology of biotechnology.

c) Furnishing information on the fund needed for technological development and commercialization of biotechnology.

d) Introducing and acting as intermediaries for joint research in technological development related to biotechnology.

(d) Administration, etc.

a) Officers-- President: Takeshi Omura (professor emeritus, Kyushu University)
Vice-Presidents, 3
Secretaries, 8; Directors, 2; and others.

b) Business office: Kumamoto Branch Office, AFF Finance Bank

(e) Status of Kyushu Region Biotechnology Conference, etc.

(a) Composition

	Sponsor (business office)	Composition
Kyushu Region Biotechnology Conference Seminars on products Seminars on food industry Seminars on animal industry intended for prefectures and the public	Kyushu Agricultural Administration Bureau (Planning Coordination Office). Kyushu AES. NIABR organizations (from FY 88). Kyushu Biotechnology Association (from November 1989).	National government: Head, Agricultural Administration Bureau; Head, Kyushu AES; Head, Kurume Branch Station, Vegetables and Tea Research Station; Head, Kuchinozu Branch Station, Fruit Tree Research Station; and Head, Kumamoto Cattle Breeding Stock Station. Prefectures: Head, General Affairs, Agricultural Administration, and Head, Biotechnology Related Locations. Universities: Hiroyuki Amano, professor, Faculty of Engineering, Kumamoto Institute of Technology. Yasunari Ogata, professor, Faculty of Agriculture, Kyushu University. Kiyohiko Ogawa, professor, Faculty of Agriculture, Kagoshima University. Yasuo Fukuoka, professor Faculty of Agriculture, Tokai University, Kyushu. Motokichi Hone, pres. emeritus Kumamoto Institute of Technology. Private sector: Rikiichro Otegawa, president Fundokin Shoyu. Kennosuke Honda, manager Production Management Department Kaketsuken. Masayoshi Yae, president Yae Nogei Co.

b) Status of meetings

	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89
Conference	1	2	1	0	1	1
Seminar	0	0	2	1	1	0
Lecture	0	0	0	0	0	1

(Note) Until FY 88, Kyushu Agricultural Administration Bureau had been the main sponsor.

III-4. Promotion of Biotechnology R&D, Etc., in the Private Sector

1. Promotion of R&D by Coordinating With the Private Sector

(1) Joint Research

In order to efficiently promote R&D in AFF and other related industries, the Joint Research System was established in 1981. "Varietal Breeding" was added to the subject fields in 1984.

Furthermore, in 1988, the Joint Research Exchange System was established to make possible exchange and acceptance of researchers, and mutual uses of research facilities.

(Major Accomplishments to Present)

- Development of high speed electric automatic cell manipulation instrument.
- Development of cell fusion technique for the citrus family of plants and production of "Oretachi" and other hybrid plants.
- Development of erythrotol (low calorie sweetner) manufacturing process.
- Development of freeze-resistant baker's yeast using cell fusion and other techniques.

(Change in Number of Ongoing Projects)

(As of 1 April 1990)

Type / Year joint research project started	Number of projects						
	Food processing and utilization	Breeding	Measurement	Others	Total	Ongoing	Completed
1982	4	–	2	1	7	–	7
1983	9	–	2	1	12	–	12
1984	7	2	1	1	11	–	11
1985	10	2	2	4	18	1	17
1986	6	6	1	–	13	1	12
1987	7	4	1	23	35	19	16
1988	7	2	1	25	(12) 35 (9)	(10) 12 (9)	(2) 23
1989	4	3	–	16	23	21	2
Total	54	19	10	71	(21) 154	(19) 54	100

Note: The numbers inside ( ) are joint exchange projects.

(2) Accepting and Assigning Research

Requests for research from the private sector are accepted and consigned to private organizations or universities.

(3) Researcher Circulation System (Period: 1 to 3 Months)

Under this system, researchers from one national research institute are invited to other national research institute for the purpose of making experimental research more efficient. Since July 1984, the private sector has also been included in the system.

2. Assistance for the Private Sector

In order to promote R&D in biotechnology in the fields of AFF and food industries, it is important to utilize the potentials of private enterprises actively engaged in R&D. Guidance and assistance are therefore provided for private joint research in the development of common, basic biotechnological technologies and their practical applications. (One half of the budgetary measure is for assistance.)

(Assistance for R&D)

(1) Development of Technologies for Transforming Plant Cell Phenotypes by Introduction of Organelles, Etc., Into the Cell (FY 89-93)

FY 90 Budget (FY 89 Budget)
Millions of ¥
38 (39)

1) Objectives

The basic technologies necessary for the introduction and the expression of cellular organelles (mitochondria, chloroplast, etc.) or chromosomes associated with useful phenotypes will be established for the purpose of producing superior plants or production of useful substances by the cells of transformed phenotype.

2) Major Technology Development Projects

(a) Development of a technology for isolation of cellular organelles, etc.

(b) Development of a technology for introducing cellular organelles, etc., into the protoplast.

(c) Establishment of a method for selection of the protoplast for the introduction.

(d) Development of a technology for expression of the phenotype.

(2) Development of a Large-Scale, High-Density, Ultrahigh Pressure, Culture Food Production System (FY 89-92)

Millions of ¥
134 (139)

1) Objectives

Under ultrahigh pressure, the productivity of a food manufacturing process may be raised as activities of enzymes are elevated, microbes are killed at a relatively low temperature, and the concentration of dissolved oxygen becomes higher. Therefore, a food production system that organically combines the ultrahigh pressure technology (mostly for sanitation) and the high-density, large-scale culture technology (for shortened production time and higher productivity) will be developed to greatly shorten the manufacturing time and vastly elevate the productivity of food production.

2) Major Technology Development Projects

(a) To search for useful microorganisms (enzymes) that exhibit higher productivity (reaction efficiency) under ultrahigh pressure (several thousand times the atmospheric pressure), and to provide the equipment for high-density, large-scale culture.

(b) Development of the monitor system (apparatus for measuring the density of microorganisms, apparatus for measuring the dissolved oxygen, etc.,) that withstands the ultrahigh pressure and the fixation base.

(c) Development of control technologies to maintain the ultrahigh pressure condition and to combine them into a system.

(3) Development of Technologies To Utilize Highly Efficient Systems of Biosynthesis for Raising the Productivity of Agricultural Chemicals (FY 89-93)

Millions of ¥
38 (39)

1) Objectives

The aim is to apply effectively intrinsic biosynthetic functions of microorganisms and plants to raise production of substances useful as agricultural chemicals. To be developed are purification methods, with high recovery, of useful substances produced by the organisms; recovery technologies and infection of plant viruses; and technologies for highly efficient production of physiologically active useful substances by plant cell culture utilizing propagation and other functions. The results of these basic research will be used as the basis for efficient production of agricultural chemicals.

2) Major Technological Development Projects

(a) Development of technologies to utilize transformations by microorganisms and enzymes

Development of the technologies for the efficient production of agricultural chemicals by utilizing the properties of microorganisms and enzymes to transform substances with high efficiency and selectivity.

(b) Development of technologies for applications of highly functional plant cells

Development of the technologies to raise the production rates of useful substances by plant cells, etc., infected with viruses, bacteria, etc.

(c) Development of technologies to improve biosynthetic functions

a) Development of the technologies for finding and producing microorganisms and physiologically active components for production of agricultural chemicals with new active properties.

b) Development of the technologies for efficient production of physiologically active micro constituents by improving the functions of the systems of biosynthesis.

(4) Development of Basic Technologies for Practical Applications of Protozoan Disease Vaccines by Gene Manipulation (FY 89-93)

Millions of ¥
36 (37)

1) Objectives

The medicines for prevention and treatment of protozoan diseases of domestic animals and fowl are limited in both the kind and applicable period of time from the viewpoint of safety. These have been vexing problems. Among these diseases, leucotizon disease of chicken is a disease caused by a protozoan parasite in the blood. Vaccines for this disease will be developed using biotechnology. The result will be used as the technological basis for the development of vaccines applicable to other protozoan diseases.

2) Major Technology Development Projects

(a) Research in the immune property of leucotizon protozoa

a) Isolation, purification and identification of immunity inducing substances.

b) Analysis of DNA of immunity inducing substances.

c) Large-scale production of useful constituents based on DNA recombination technology.

(b) Research in vaccines production

Test production of vaccines and trials inside the laboratory and in the field.

(5) Analyses of Structures of Genes of Agricultural Plants and Animals (FY 86-90)

Millions of ¥
32 (33)

1) Objectives

DNA recombination technologies need to be developed for achieving efficient production of useful substances by agricultural plants and animals. Isolation and structural analysis of genes, the bases of these technologies, will be carried out and useful information of genes will be collected and preserved.

2) Major Technology Development Projects

(a) Isolation of useful genes.
(b) Cloning of useful genes.
(c) Analyses of the structures of useful genes.

(6) Development of a New Hybrid Breeding System for Seedling Industry (FY 88-92)

Millions of ¥
51 (52)

1) Objectives

The aim is to raise the capability of the seedling industry in this country to develop new varieties. The development of basic technologies for this will be promoted by establishing a system of efficient breeding and seeds harvesting of new varieties of vegetables and others by applying aggressively the results of biotechnology and other forefront technologies.

2) Major Technology Development Projects

(a) The technology for growing fast maturing, male sterile cell lines by the application of nonsymmetrical fusion method, etc.

(b) The technology for producing superior phenotypes by utilization of cell mutations.

(c) The technology for introducing useful phenotypes from closely related wild varieties with embryo and ovule culture.

(d) The technology for producing fast maturing, pure lines of organisms by using reproductive cell lines (haploids).

(e) The system for large-scale production of uniform, mating parents by using indefinite embryo lines.

(7) Development of Technologies To Alter Functions of Enzymes Used in Food Industry (FY 87-91)

Millions of ¥
100 (103)

1) Objectives

To develop the technologies to alter the enzymatic functions that may help solve the problems of hygiene management and productivity increase in food manufacturing.

2) Major Technology Development Projects

(a) Analyses of the structures of natural enzymes.
(b) Analyses of the structures of enzymes used in food industry.
(c) Designing enzymes with altered functions.
(d) Test production of enzymes with altered functions and development of systems for their utilization.

(8) Development of Technologies To Alter and Elevate Functions of Food (Development of Food Design Technology) (New) (FY 90-93)

Millions of ¥
89 (0)

1) Objectives

The aim is to produce high quality food materials with superior nutritional and palatal properties. Biotechnology which has seen tremendous progress in recent years will be introduced, and practical technologies that apply high production potentials of microorganisms and cells of specific plants and animals into the field of food manufacturing (Food Design Technology) will be developed.

2) Major Technology Development Projects

(a) Development of technologies to breed microorganisms, etc., useful in food manufacturing using biotechnological techniques such as cell fusion, etc.

(b) Establishment of technologies for propagating fused microorganisms, etc.

(c) Development of systems of culture, isolation and purification.

(9) Development of Basic Technologies for Development of New Fertilizers Using Biological Activities (FY 86-90)

Millions of ¥
50 (51)

1) Objectives

The aim is to respond to the problems of salt accumulation, nutrient loss, eutrophication of lakes and streams, etc.; to plan for effective utilization of residual organic compounds; and to help raise agricultural production and productivity of the land. Hitherto accumulated basic technologies for application of biological activities will be utilized to develop the basic technologies for the development of new fertilizers. These new fertilizers will have characteristics of efficient utilization of the activities of microorganisms, fitting nicely to the absorption characteristics of crops, etc.

2) Major Technology Development Projects

(a) Development of technologies for production of fertilizers utilizing biological activities.

(b) Development of technologies for production of fertilizers that possess the fertility adjusting function.

(Assistance for Development of Industrialization Technologies (Limited to major new projects only))

(1) Tasks for Elevating the Level of Water Treatment Technology in Food Industry Using Microorganisms (New) (FY 90-92)

Millions of ¥	
102	(0)

1) Objectives

The aim is to treat plant and animal residues with high water content, and waste waters with high contents of oil and fat, salt, etc., of food industry. Elevation of the level of waste water treatment technology will be promoted with development and improvement of humus type bioreactors that utilize the function of soil microorganisms, and waste water treatment technology that utilizes microorganisms (Clean Ecosystem).

2) Major Technology Development Projects

(a) Development of humus-type bioreactors

- Development of the technology of a humus-type bioreactor for use with plant and animal residues having high water content.
- Development of the technology of a humus-type bioreactor for use with residues having high contents of plant and animal lipid, etc.
- Development of the technology of a humus-type bioreactor for use with residues with high BOD, etc.

(b) Development and improvement of waste water treatment technologies utilizing microorganisms

Development and improvement of a lower cost and higher efficiency system utilizing microorganisms as compared with the waste water treatment technologies currently in use (development of waste water treatment technology that responds to violent changes in treatment temperature, organic compound concentration and other conditions).

(2) Tasks for Promotion of Development of New Wood Materials (New) (FY 90-93)

Millions of ¥	
96	(0)

1) Objectives

Until now, wood processing has been limited to mechanical means of sawing, shaving, etc. By chemically modifying the OH functional group of wood cellulose with high molecular weight substituents, wood can be made into thermoplastic or liquid, and it is possible to change the shape of wood by press molding, injection molding, etc. The field of wood application thus is expected to be expanded immensely.

Moreover, technologies for efficient isolation of major constituents of wood, hemicellulose, lignin, and cellulose, will be developed. Effective utilizations of unused wood resources will be advanced by the development of technologies for the production of a useful sugar, xylitol, from hemicellulose, carbon fiber from lignin, and alcohol and fiber, etc. from cellulose.

2) Major Technology Development Projects

(a) Development of experimental plants for conversion into thermoplastic and liquid.

(b) Development of technologies for utilization of thermoplastic and liquid woods.

(c) Development of technologies for expanded utilization of major wood constituents.

(3) Development and Test of Technologies To Prevent Red Tide Damages With the Application of Marine Biotechnology (New) (FY 90-94)

Millions of ¥
42 (0)

1) Objectives

The technology to predict the red tide occurrence will be developed from the elucidation of the biological antagonism toward red tide. By combining already developed various technologies, the technologies for controlling or preventing the red tide occurrence will be developed. The technology to simplify the identification of red tide plankton strains and the measurement of their quantities which, at present, require practice will be developed. Thus, necessary basic technologies for the prevention of red tide damages and for the technology to respond to the red tide will be developed.

2) Major Technology Development Projects

(a) Development of technologies to prevent red tide damages by the utilization of bacteria associated with red tide planktons

Bacteria are divided into red tide promoting or controlling group. The occurrence of red tide will be predicted from the bacterial phase of the fishing ground. The technology to prevent the red tide occurrence using the substances produced by bacteria that obstruct the red tide occurrence will be developed.

(b) Development of technologies to prevent red tide damages using monoclonal antibodies

Monoclonal antibodies will be prepared for each strain of red tide plankton. This will make the identification and quantification of red tide plankton strains easier. By linking the substances obstructing the

red tide occurrence with the antibodies, an efficacious red tide prevention technology can be developed.

(c) Development of technologies to prevent red tide damages by the use of DNA segments

DNA segments have been used in the classification of fish and shellfish. The same when applied to the classification of red tide plankton can lead to the basic information needed for accurate red tide preventive measures, such as improvement of the environment, obstructing bacteria, monoclonal antibodies, etc.

(d) Consignees: Municipalities, regions, prefectures, universities and private companies.

3. Establishment of Private Research Promotion Office

The Private Research Promotion Office was established on 11 June 1990 within the Promotion Division, Administration Bureau, AFF Technology Conference for the purpose of assisting and promoting private research related to AFF and food industries that apply forefront technologies such as biotechnology, electronics, etc.

(Organization of Private Research Promotion Office) [Organization chart on next page]

4. Other Promotion Measures

(1) Tasks of Biological System Research Organization

To invest in or loan the funds for research conducted by the private sector in specific biology related industrial technologies with primary emphasis on biotechnology (at present, technologies involved in AFF industries, food and beverage manufacturing, tobacco manufacturing, wood product manufacturing, and selling of food, beverages, and tobacco).

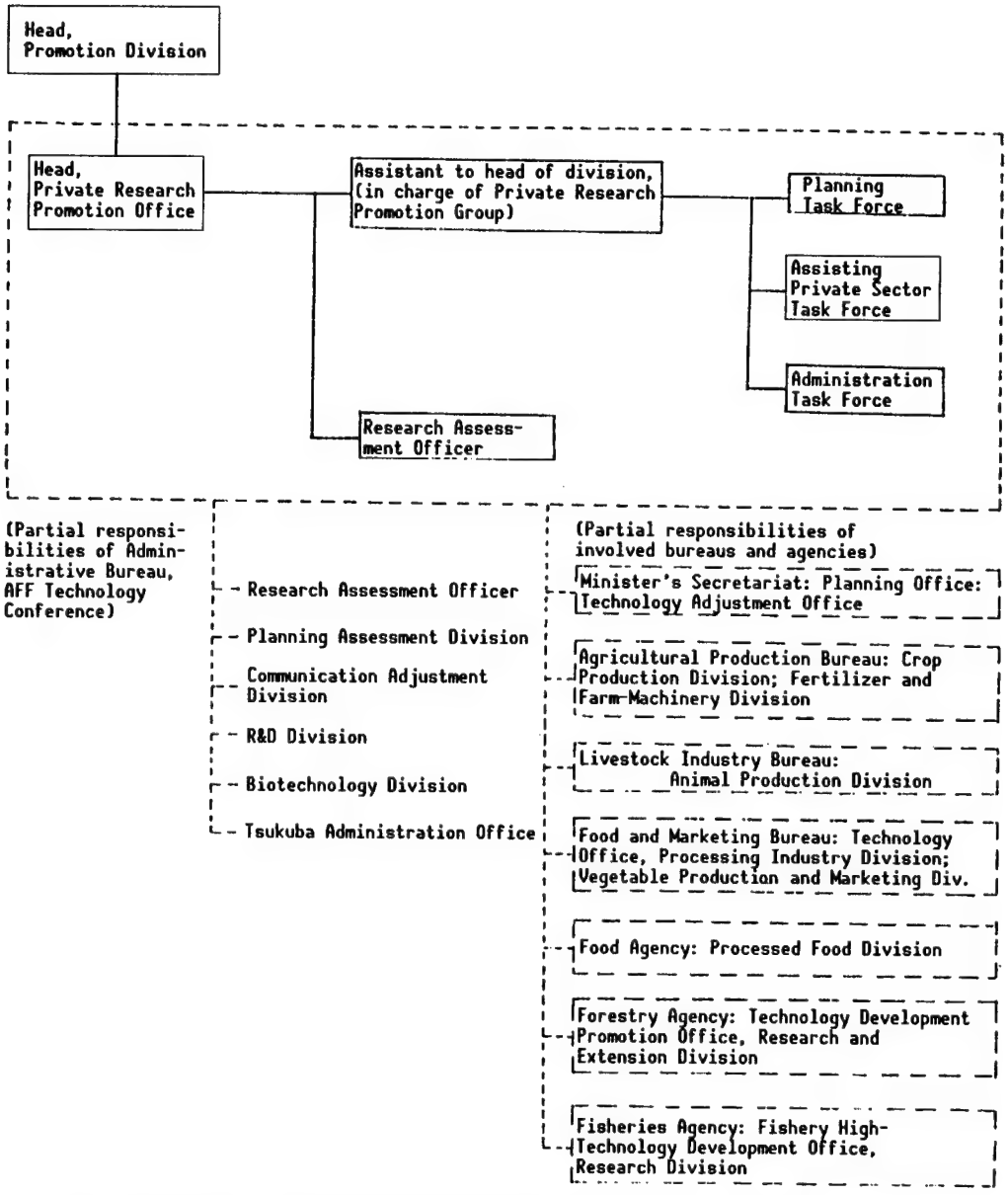
Scope of FY 90 Tasks	(FY 89)
Millions of ¥	
1,900	(1,700)

1) Tasks of Investment Fund

Investment of the fund will be done in the form of getting the shares of joint technology development corporations (limited to those allocating the investment funds) that have been set up jointly by more than two enterprises, AFF associations, regional public associations, etc.

(a) Proportion of investment

Up to 70 percent of the fund needed for research (excluding the land cost).



Organization of Private Research Promotion Office

(b) Investment period

As a principle, up to 7 years (up to 10 years under a special need circumstance).

2) Tasks of Loan for Research

Loans will be provided for research on specific biology related industrial technologies conducted by enterprises, AFF associations, nonprofit organizations, etc., under the following conditions:

(a) Proportion of loan:	Up to 70 percent of the expenditures of the object of the loan (expenditures and costs for facilities, equipment, laboratory construction, materials, supplies, labor, orders, and overhead).
(b) Loan period:	Till the completion of the research, as a principle, less than five years.
(c) Repayment period:	As a principle, within 15 years (including five years of the loan period).
(d) Interest, etc.:	No interest on a condition (in the event the research is successful, interest will be charged in proportion to the degree of success).
(e) Reward for success:	An interest rate based on the degree of success will be determined, and the sum equivalent to simple interest on the annual basis for the years the loan had been in effect will be levied.
(f) Collateral and guarantee:	As a principle, required.

3) Act as intermediary in the joint research of private enterprises, etc., and governmental research institutions

4) Intermediating in provision of gene resources of plants, etc., of "AFF Gene Bank" to private enterprises, etc.

5) Others, such as invitation of overseas researchers, research consignment, information furnishing, survey, etc.

(Summary of Investments in Biology Related Research Organizations)

1) Selections for FY 86

Name of corporation	Research subject	Major invested companies	Period (yrs)
Hokkaido Green Research Laboratory, Inc.	Research in biodevelop-ment of freeze-resistant plant resources by applying biotechnology	•Hokuren Federation of Agricultural Cooperatives •Federation of Hokkaido Agricultural Credit Association •Federation of Hokkaido Agricultural Mutual Association •Federation of Hokkaido Agricultural Welfare Association •Hokkaido Development Bank •Hokkaido Bank •Hokkaido •Hokkaido Electric Co. 2 other companies	7
Okinagarabu Bulbs Research Laboratory fast, large-scale	Research in biotechno-logical breeding of flower bulbs and a culture	•Kazuhaku Cho •Kazuhaku Cho Agricultural Cooperative •Tomona Cho •Tomona Cho Agricultural Cooperative •Nanei Sugar Co. •Nagarabe Lily Freezer Production and Shipping Association •Kyowa Hakko Kogyo Co.	7
Nursery Technology, Inc.	R&D of a large-scale system of propagation of seedlings	•Kirin Beer Co. •Kyowa Hakko Kogyo Co. •Nippon Steel Corp. •Daisei Construction Co. •Federation of Hiroshima Prefecture Agricultural Credit Association •Federation of Saga Prefecture Agricultural Credit Association	7
Iwate Biomass Research Center, Inc.	Research in technologies for efficient utilization of woody biomass, conversion into feed, etc.	•Hitachi Ship Building and Engineering Co. •Nippon Steel Corp. •Federation of Iwate Prefecture Agricultural Credit Association	6

[Continuation of table]

Name of corporation	Research subject	Major invested companies	Period (yrs)
Brewery Resources Research Laboratory, Inc.	R&D in gene resources of brewery micro-organisms	•Asahi Beer Co. •Kyowa Hakko Kogyo Co. •Gekkeikan Co. •Suntory Co. •Takara Brewery •Nikka Whisky Co. •Japan Brewers Association •Oseki Brewery •Kirin Beer Co. •Sapporo Beer Co. •Sanraku Co. •Toyo Brewery •Shirotsuru Brewery	7
Nissan Seedlings Development Center, Inc.	R&D in biological feed for fisheries	•Nissin Oil Mills, Ltd. •Mitsui Ocean Development Co.	6
Sea Techs, Inc.	R&D in undeveloped fishery systems for high-quality fish	•Mitsubishi Mining and Cement Co. •Mitsubishi Coal Mining Co. •Taiyo Fishery Co. •Nagasaki Prefecture •Takashima Cho 11 other Mitsubishi companies	5

2) Selections for FY 87

Name of corporation	Research subject	Major invested corporations	Period (yrs)
Process Rice Breeding Research Laboratory	Research in development of rice varieties suitable for processing	•Nippon Tobacco Industry, Inc. •Japan Brewery Association •Kirin Beer Co. •Tokyo Municipality Brewery and Distillery Association •Tohoku Electric Co. •Japan Grain Inspection Association	7
Green Environment Resources Development Center	Research in production of indoor plants and establishment of a hydroponic culture system	•Hitachi Ship Building and Engineering Co. •Ohbayashi-Gumi, Ltd. •Ube Industries, Ltd. •Fujisawa Pharmaceutical Co. •Sanwa Bank •Osaka Cement Co. •Kurogane Kosakusho, Ltd. •Zenitaka Corp. •Daisue Construction Co. •Toyo Construction Co. •Nissho-Iwai Co. •Uchiyama-Ryokuchi Construction Co.	7
NT Science	Research in technology for production of superior experimental animals using biotechnological techniques	•Nisseiken Co. •Toso Co.	7

3) Selections for FY 88

Name of corporation	Research subject	Major invested corporations	Period (yrs)
Japan Turf Grass	Research in development of improved varieties of turf grass and propagation technologies	•Nippon Horse Race Facilities, Inc. •Taisei Construction Co. •Nippon Agricultural Chemicals, Inc. •Toyo Green Co.	7
Gifu Immunology Laboratory	Research in development of immune agents against various infectious diseases of livestock	•Gen Corporation •Joint Organic Industry Research Laboratory	6
Wakayama Agri-Bio Research Center	Research in development of a technology for scientific production of orange juice using micro-organisms	•Wakayama Prefecture Federation of Agricultural Cooperative •Asahi Beer and Beverage Manufacturing Co. •Toyo Seikan Kaisha, Ltd. •Wakayama Nokyo Food, Ltd. •Wakayama Prefecture Agricultural Products Processing Research Institute	7
High Quality Cold Water Fish Culture Technology Research Laboratory	Research in improvement of quality of cold water fish and development of a new culture system	•Nippon Suisan Kaisha, Ltd. •Nichimo Co., Ltd. •Nippon Steel Corp. •Nissan Construction Co. •Iwate Prefecture Federation of Fisheries Cooperative	6

4) Selections for FY 89

Name of corporation	Research subject	Major invested companies	Period (yrs)
Techno-Grafting Research Laboratory	Development of technology for large-scale production of superior grated seedlings	•Nippon Tobacco Industry, Inc. •Komatsu, Ltd. •Toshiba Co., Ltd. •Kajima Corp. •National Federation of Agricultural Cooperatives	7
Crop Cultivation Management System Research Association	Development of robots for use in agriculture and a precise management system compatible with crop physiology	•Kubota, Ltd. •Ikegami Tsushinki Co., Ltd.	7
Functional Peptide Research Laboratory	Development of a nonplasma culture base with known composition to be used for livestock ova	•Bio-Science Research Laboratory •Livestock Improvement Association •Yamagata News, Inc. •Tohoku Electric Co. •Intelligent Cosmos Research Institute 6 other companies	3
Nematec	Development of technology to reduce nematode damage with their natural enemies	•Yasudoya Chemical Co. •Sankei Chemical Co.	7
Nondestructible Fruits Research Laboratory	Development of a quality automatic system to select nondestructible fruits	•Maki, Ltd. •Himamatsu Photonix, Inc. •Federation of Aihime Prefecture Fruit Growers Cooperative	7

(Total Number of Investments and Loans (FY 86-89))

Field	Number of investments	Number of loans
Related to breeding and cultivation of crops	7	18
Related to agricultural chemicals and materials	1	5
Related to machineries and facilities	2	3
Related to livestock production	4	12
Related to food and fermentation	2	25
Forestry related	-	5
Fisheries related	3	10
Total	19	78

(2) Augmentation of Finance and Tax Measures for Promotion of R&D and Industrialization

1) Funding Programs

Since FY 88, the following programs have been in effect, for addition of biotechnology related facilities, to augment and reinforce the policy.

System/ Loan object	Involved parties	Interest/ Loan limit/ Repayment period	Remarks
Agriculture Improvement Fund/ Facilities for biotechnology (production and propagation of virus-free seedlngs)	Farmers	None 80% Within 5 years (including first year of loan placement)	Facilities at left are added to objects of the loans for introducing energy saving

[continued]

[Continuation of table]

System/ Loan object	Involved parties	Interest/ Loan limit/ Repayment period	Remarks
AFF Finance Bank Fund/ Facilities to be used jointly for production of AFF products applying biotechnology Research facilities for breeding new varieties, etc.	Those involved in AFF activities and corporations (including joint-stock corporations) organized by them	5.1% 80% Within 20 years (including first 3 years during in which loan is placed). 5.1% 80% Within 15 years (including same first 3 years)	Facilities at left added to joint use facilities of AFF Facilities Fund Facilities at left are added to minister-in-charge designated facilities of AFF Facilities Fund
Japan Development Bank Fund/ Facilities and equipment for manufacturing food and beverage, oil and fat, or materials to be used specifically for AFF productions applying biotechnology	Enterprises, nonprofit corporations, etc.	5.05% 40% Within 15 years (including the same first 3 years)	Facilities and equipment at left added to objects of small item loans for "Promotion of Biotechnological Industrialization"
Hokkaido-Tohoku Development Bank/ Same as above	Same as above	5.05% 70% Within 15 years (including the same first 3 years)	Newly establish a special profit system of "Promotion of Commercialization of Regional Biotechnology"

2) Tax Measures

For the purpose of assisting biotechnology R&D in the private sector, a special three-year exemption for national income and corporation taxes has been in effect since FY 85. At the local level, a special two-year exemption for tax on fixed assets has been in effect since FY 86. The effective applying periods of these have been extended by the tax reforms of FY 88 and FY 90.

(a) National Tax

Individuals and corporations, those required to file the blue tax-return forms, are allowed to add 7 percent of the cost of machines and facilities that have been acquired, manufactured, or constructed for basic technology R&D to the credit for the expenses for addition to research and is substracted from the individual and corporation income taxes from 1 April 1988 to 31 March 1993. (Total tax credit, limited to 15 percent of the current tax.)

(Object Machines and Facilities)

Gene recombination laboratory, laboratory safety cabinet, laboratory autoclave, automatic colony transplanter, equipment for cell and tissue culture experiment, equipment for cell fusion experiment, cell isolation equipment, cell micro manipulation device, bioreactor experiment device, nucleic acid purification apparatus, automatic nucleic acid segmentation device, nucleic acid synthesis apparatus, peptide purification apparatus, automatic peptide segmentation apparatus, peptide synthesis apparatus, amino acid analyzer, immunity measuring device, electronic microscope, ultrasonic microscope, spectrophotometer, X-ray spectrometer, mass spectrometer, NMR spectrometer, and supercritical chromatograph.

(1 October 1987 Additions)

Centrifuge for separation of metabolites of microorganisms and cells, devices for determining the culture condition of microorganisms and cells, plant adaptation device, laser gene injection device, automatic DNA extractor, and DNA base sequencer.

(1 April 1990 Additions>

Automatic DNA multiplier, cellular calcium analyzer.

(b) Local Tax

The fixed asset tax rate for the research equipment and facilities that are acquired, manufactured, or constructed during 1 April 1987 to 31 March 1991 for the purpose of safe execution of the research in gene recombination technology and its application technologies shall be assessed at two-thirds of the standard taxable value for three years from the year it is newly taxed.

(Object Equipment and Facilities)

Laboratory ventilating and ultraviolet light illumination devices for gene recombination experiments, laboratory safety cabinet, laboratory autoclave, closed type bioreactor experiment device, nucleic acid purification apparatus, peptide purification apparatus, and automatic peptide segmentation apparatus.

(1 April 1987 Additions)

Closed type centrifuge for separation of metabolites of microorganisms and cells, closed type plant adaptation device, and nucleic acid base sequencer.

(1 April 1990 Addition)

Automatic nucleic acid multiplier.

(Other Related Tax Measures)

- Mining Industry Technology Research Association

    (a) National Tax (continued)

    The Mining Industry Technology Research Association's share of the cost of acquisition or manufacturing of necessary equipment and devices incurred on or before 31 March 1991 can be optionally depreciated and the account value of the research facilities thus obtained can be reduced down to ¥1.

    (b) Local Tax (extension of the effective period)

    The fixed-asset tax rate for those equipment and devices that are recognized by Rule 14 of the Mining Industry Technology Research Association Law acquired or manufactured on or before 31 March 1991 shall be three-fourths of the standard rate for three years starting from the year it is newly taxed.

- Biological System-Specific Industrial Technologies Research Promotion Organization (established in FY 88)

    This concerns the special exemption for the corporation tax when the research expenditure increases, etc. Under a specific circumstance, 20 percent of the investment of private enterprises to research companies that are funded by biological research organizations can be added to the account of increased research expenditures.

III-5. Promotion of Basic Research in Coordination With Universities

Research in Cultivation of Seeds of Forefront Technologies of Biotechnology

Research in cultivation of seeds pertains to planning for cultivation and growth of seeds and seedlings (basis) of future technological development in biotechnology, which is expected to see rapid development in its technologies. Since FY 84, the following projects have been consigned to research institutions such as universities capable of carrying out these forefront and interdisciplinary research.

FY 90 Budget (FY 89 Budget)
Millions of ¥
103 (103)

Research project	Experimental subject
I. Research in elucidation of expression of high order information in chromosomes of plant nuclei 1. Elucidation of high order functions that control recombinations and expressions of plant genes. 2. Elucidation of functions and structures of plant chromosomes at molecular level. 3. Elucidation of functions of plant cells for purpose of manipulating chromosomes. Principal investigator: Kaku Watanabe, professor emeritus Keio University Research period: FY 89–93	1. Elucidation, at molecular level, of mechanism of recombination of an introduced gene into a chromosome. 2. Elucidation of mechanism of changes in plant chromosomes induced by transition factors, etc. 3. Elucidation of high order function that controls plant gene expressions. 4. Elucidation of locations of stabilizing function in plant chromosomes. 5. Basic research in plant recombination technology using artificial chromosomes. 6. Elucidation, at molecular level, of specific structures during the meiosis of plant cells. 7. Elucidation of expressions of high order information of cellular genes. 8. Elucidation of stabilization of introduced chromosomes by mini-protoblast.
II. Basic research in development of chemomimetic enzymatic reaction system 1. Altering substrate specificity by a chemomimetic reaction. 2. Introduction of enzymatic function into specific biological, high molecular weight molecules. [continued]	1. Alterations of reaction characteristic and substrate specificity of glucoamylase. 2. Expansion and contraction of substrate specificity of protease. 3. Design and synthesis of RNA enzyme. 4. Elucidation of basic techniques for preparation of antibody enzymes. [continued]

[Continuation of table]

Research project	Experimental subject
3. Development of highly functional enzymes by combination of chemomimetic techniques and protein engineering techniques. Principal investigator: Shuichi Suzuki, professor, Saitama Institute of Technology Research period: FY 90-94	5. Preparation of new enzymes by introduction of nonnaturally occurring amino acids. 6. Design and features of artificial enzymes of bimolecular membrane type. 7. Alteration of enzymatic function of lipase, etc., using chemomimetic techniques.
III. Research in elucidation of genes of animals 1. Analysis of structures of and elucidation of mechanisms of expression gene association with useful livestock phenotypes. 2. Elucidation of genes of oceanic organisms involved in material production and metabolism, and expression mechanisms. Principal investigator: Kazunari Yamauchi, professor, Faculty of Medicine Tokyo University Research period: FY 88-92	1. Basic research in technologies for manipulating DNA of animal viruses. 2. Mechanism of expression of phenotype transforming gene introduced into an early term embryo. 3. Elucidation of mechanisms of expressions of functions by reconstruction of genes of immune cells. 4. Elucidation of structure and function of genes compatible with major tissues. 5. Elucidation of controlling region and enhancer of expression of animal genes specific to a tissue. 6. Development of cloning vectors for large segments of DNA (500 kb level). 7. Elucidation of mechanisms of production of physiologically active substances by oceanic organisms. 8. Elucidation of metabolites of oceanic organisms and genes involved in their production and storage. 9. Elucidation of control mechanism of growth of oceanic organisms. 10. Basic research in development of a vector system for oceanic organisms.

(Note) Projects conducted within Japan only. See "III-6. Status of International Research Exchange" for those consigned to overseas organizations.

III-6. Status of International Research Exchange

1. International Exchange of Post-Doctorate Level Researchers

As one of the ways of research cooperation with developing nations, post-doctorate level researchers from developing nations are invited to our country to conduct joint research, mainly in the DNA recombination technology. This was started in FY 88 (two persons for five months).

During FY 88, one each from Thailand and Malaysia, and in FY 89, one each from Thailand and the Philippines were invited to NIABR.

2. Research Cooperation Based on Bilateral Science and Technology Cooperation Treaty Between Two Nations

In accordance with the Two Nations Bilateral Science and Technology Treaty, various cooperative research has also been carried out in AFF fields. In recent years, cooperative projects in the field of biotechnology have been increasing. Among these, based on the cooperative project that was signed in June 1988 with the United States, the cooperative projects in life science and other fields were agreed by the high level joint committee in May 1990.

3. International Joint Research in Forefront Technologies

In order to efficaciously carry out basic research in biotechnology, etc., joint research with advanced European and American nations and workshops have been started.

(1) International Joint Research

1) Researchers are sent to the United States for a long-term stay to conduct "research in the elucidation of cis-trans components involved in the expression of genes of plants of higher orders" (FY 89-91).

2) Researchers from the United States are invited for a long stay to conduct "research in the elucidation of the differentiation mechanism of the nervous system during the embryo developmental stage of insects" (FY 90-92).

(2) International Workshops

"Elucidation of Inter-Microorganism Antagonisms in the Ecosystem of Cultivated Fields" (FY 90 Subject).

4. Foundation Forming Research Consigned to Overseas for Assembling the Best Brains

FY 90 Budget (FY 89 Budget)
Millions of ¥
15 (0)

In order to raise the level of research in the field of biotechnology in our country, the forefront research projects that have not previously been carried out in our country will be consigned to researchers in overseas universities for cultivating the seeds by assembling the overseas best forefront brains.

- Research Subject

  Basic research in the development of useful transgenic large livestock animals (FY 90–94)

5. Various Research Exchanges

Using the program of the Science and Technology Agency, our researchers are being sent to research organizations of various nations and international research meetings, and foreign researchers in biotechnology and other fields are invited to our country.

III-7. Preparation of the Foundation for Advancement of Biotechnology

1. Training of Personnel for Biotechnology

(1) Entrusted Researchers System

In this system, researchers from municipalities, regions, prefectures, private enterprises, etc., are accepted into national research institutes to receive training in research for two to six months. Since FY 84, the biotechnology field has been specifically set up to accept the researchers. Furthermore, since FY 88, specialized entrusted researcher courses (nine months) have been established to strengthen the acceptance system.

- Status of Acceptance (Biotechnology Related)

FY	Total	From private sector	From municipalities, regions, prefectures
84	51	14	37
85	80	19	61
86	88	11	77
87	76	18	58
88	67	28	39
89	62	22	40

(2) Short Courses for Groups of Researchers From Municipalities, Regions, and Prefectures in AFF Related Fields

Aiming at researchers in municipalities, regions, and prefectures, instructions in the newest, high-level research theories, research methods, research results, etc., are conducted for short-term, systematic studies.

• Status of Instructions Conducted (Biotechnology Related)

FY	Period of study	Subject of study	Number attended
84	17 Dec~22 Dec 84	•Biotechnological technologies in AFF related research organizations	75
	25 Mar~30 Mar 85	•Biotechnological technologies in AFF related research organizations	57
85	20 Jan~22 Jan 86	•Breeding technology using culture systems	52
86	9 Mar~12 Mar 87	•Biotechnological technologies in AFF related research organizations	50
87	14 Mar~18 Mar 87	•Biotechnological technologies in AFF related research organizations	53
88	23 Jan~27 Jan 89	•Biotechnological technologies in AFF related research organizations	51
89	4 Dec~ 8 Dec 89	•Biotechnology in AFF research pertaining to plants pertaining to animals	 36 22

(3) Elevation of the Quality of National Researchers

1) Within the Country Study Program

(a) Under MAFF Jurisdiction

Dispatching researchers to universities, research laboratories of other ministries and agencies, and AFF research laboratories other than their own (two months to one year).

(b) Under STA Jurisdiction

Dispatching to national universities and natural science laboratories used jointly by national universities.

2) Overseas Study Program

(a) The program of dispatching researchers for long-term study overseas (one year) under the jurisdiction of STA.

(b) The partial guaranteed researcher dispatching program (six months to one year) under the jurisdiction of STA.

(c) The all guaranteed researcher dispatching program (six months to one year) under the jurisdiction of STA.

3) Biotechnology Study of MAFF Researchers

The purpose is to systematically study the newest biotechnological research theories and methods.

• Status of Study and Number of Persons Attended

	FY 86 (20 days)	FY 87 (3-6 months)	FY 88 (3-6 months)	FY 89 (2-6 months)
Study of gene manipulation	4	4	5	7
Study of cell manipulation	16	5	3	1

4) Training in Genetic Engineering

To train the researchers in the overall knowledge and techniques of biotechnology centering around the DNA manipulation technique. Started in FY-88.

During FY 89, a course that includes hands-on experimentation was given at NIABR from 7-17 November.

2. Securement of Genetic Resources, Etc.

(1) Status of Preservation of Genetic Resources at MAFF

1) Status of Preservation of Genetic Resources

Within MAFF, in addition to 150,000 plant genetic materials preserved in NIABR as the major center, about 9,000 microorganisms, 20,000 plants, and 620 and 270 of land and water animals, respectively, are preserves for research purpose. (Chart 1)

2) Preparation of AFF Gene Bank

In order to fulfill the expected great advancement in the development of biotechnology, various genetic materials that are its basis must be secured in a coordinated fashion. For this purpose, since FY 85, the preparation of a system of coordinated management and utilization of overall AFF organisms (AFF Gene Bank) that include plants, animals, microorganisms, and trees (since FY 87 onward) has been in progress to collect genetic materials and genetic breeding information, and to strengthen their management. (Chart 2)

Moreover, responding to the request of private enterprises, plant genetic materials have been distributed for research purposes since January 1986 and same has been done with microorganism genetic materials since September 1987. (Chart 3)

(2) Status of Preservation of Plant Genetic Resources in Major Overseas Organizations

In the United States and the USSR, acquisition and preservation of plant genetic materials have long been emphasized as the basis for advancement of agriculture. At present, about 400,000 items are preserved at the All-Soviet Plant Production Research Institute, and about 200,000 items are preserved at the U.S. National Seed Preservation Laboratory.

Moreover, a preservation network on these is being planned centering around IBPGR [International Bureau of Plant Genetic Resources]. (Chart 4)

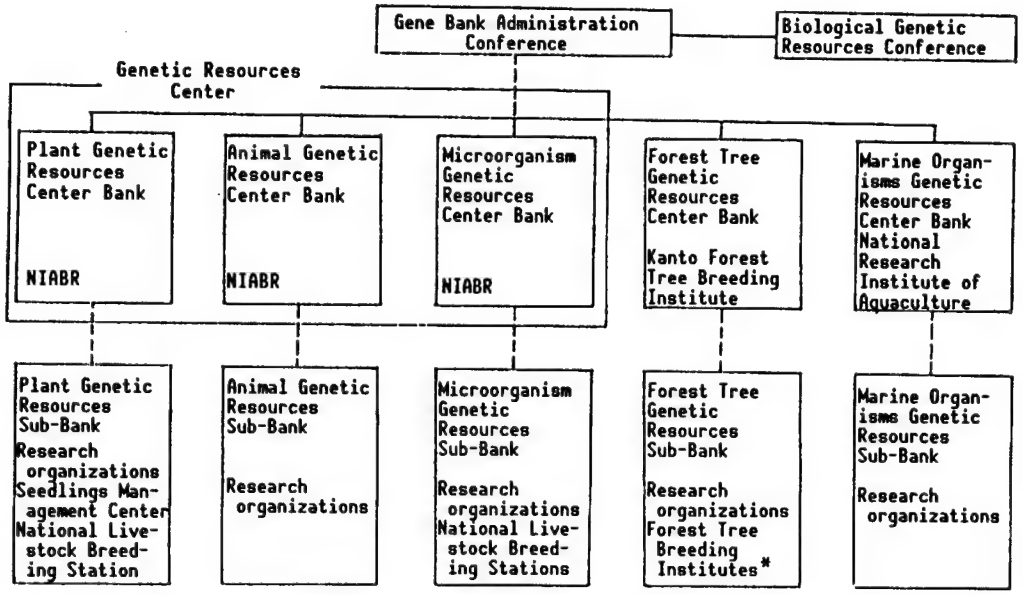
Chart 1. Collection and Preservation, Present and Target
(Present: end of December 1989; target: FY 92)

Classification	Plants	Animals	Micro-organisms	Trees	Marine organisms
Present	150,000	620	9,000	20,000	270
Target	230,000	710	130,000	25,000	2,100

3. Administration of Tsukuba Agriculture and Forestry Research Center

The center is prepared as the base for coordinating the R&D activities of industry, universities, and governmental agencies, those of overseas in basic and forefront areas of biotechnology to contribute to the exchange of researchers, and joint utilization of facilities and resources. It was completed in May 1990.

Chart 2. Organizational Chart of MAFF Gene Bank Project



*Excluding Kanto Forest Tree Breeding Institute

Chart 3. Distribution Result

Classification	Plants	Microorganisms
Universities	2,322	174
Municipalities, regions, prefectures	562	37
Private sector	1,794	217
MAFF agencies	22,986	272
Foreign countries	3,683	10
Total	31,347	710

(Note) The rules for distribution of plants were issued on 25 January 1986 and those for microorganisms were issued on 1 September 1987. The results above are those up to the end of December 1989.

Chart 4. Status of Preservation of Plant Genetic Resources in Research Institutions of Japan and Other Countries

Institutions (national)	Number of preserved systems (Unit: 1,000)	Major crops
United States*1	433	
National Seed Storage Laboratory	205	Wheat, soybean, rice
Plant Genetic Breeding Material Research Laboratory	108	Wheat, soybean, oat
3 other facilities	120	
USSR*2		
All Soviet Plant Production Research Institute	400	Wheat, barley, beans
China*3		
Chinese Crop Genetic Resources Storage Center, etc.	300	Rice, wheat, sorghum
United Kingdom*4		
Plant Breeding Research Institute	63	Wheat, barley, oat
Japan*5	150	
NIABR	83	Rice, wheat, barley,
Vegetables and Tea Research Station	16	beans, melon, egg-plant, tomato, tea
Fruit Tree Research Station	4	apple, orange, grape
Others	45	
International agencies*6		
International Rice Research Institute [IRRI]	84	Rice
International Wheat and Corn Improvement Center [CIMMYT]	50	Wheat, barley, corn
International Semi-Arid and Tropical Crop Research Institute [ICRSAT]	85	Beans, sorghum, millet

References: *1. Diversity No. 10 (1987); *2. Information Exchange in Collection and Preservation of Genetic Resources of Agricultural Crops for Varietal Improvement (Nakakawagara, Makita (1988)); *3. Hsin-Hwa She (China News Agency) cited in NIPPON NOGYO SHINBUN (JAPAN AGRICULTURE NEWS) 10 Sep 84; *4. STA Resource Council (1984); *5. Survey of Communication Preparation Division (1990); *6. Securement of Genetic Resources for Breeding, (Suzuki (1988)), but for IRRI, it is from a Report on Advancement in Tropical Agriculture Research (Saito (1988)).

III-8. On Utilization of Recombinant Organisms in AFF Fields, Etc.

1. Establishment of Guideline for Utilization of Recombinant Organisms in AFF Fields, Etc.

(1) Background

1) Recombinant DNA technology has seen tremendous progress in recent years. For productions of medicines, enzymes, amino acids, etc., various agencies of the Ministry of International Trade and Industry [MITI] and the Ministry of Health and Welfare [MHW] involved in the fields have issued the guidelines for industrial applications of recombinant organisms. Production is being made based on these guidelines.

On another front, field tests of recombinant plants have been in progress in European nations and the United States. In December of last year, the STA issued experimental standards that also encompass nonclosed systems of experiments in our country.

2) In December 1986, the MAFF made public its proposed guideline for utilization of recombinant organisms based on the advice of the OECD of July of the same year, and has since evaluated it by soliciting opinions from various sectors, etc. This time, for appropriated utilization of recombinant organisms in AFF fields, the "Guideline for Utilization of Recombinant Organisms in AFF Fields, Etc." was prepared and made known to involved parties.

(2) Basic Consideration of the Guideline and Its Major Content

1) Basic Consideration

(a) For orderly utilization of recombinant plants, the results of experiments in nonclosed systems shall be used for assessing the safety. Utilization in open systems shall proceed step-by-step with appropriated management measures placed at each step.

(b) As for recombinant microorganisms, when they are used for industrial production processes, they shall be used under specific closed conditions according to their characteristics (similar to the guidelines issued by MITI and MHW). Those whose aims are for applications in open systems, the definitive assessment of their safety shall be further evaluated.

2) Major Content

(a) Those (enterprises) that wish to utilize a recombinant organism in AFF fields shall evaluate the safety by assessing if the recombinant organisms possess any harmful form and/or nature, and shall utilize the recombinant organism according to its kind, application, and degree of safety as follows:

a) Recombinant Plant

To propagate a recombinant plant for the purpose of securing the necessary raw material for breeding, an isolated area shall be established and its safety for use in an open system shall be confirmed by using the simulated environment. When safety is confirmed, it may be used in an open system.

b) Recombinant Microorganism

(i) Utilization in a Production Process

A recombinant microorganism that has been recognized to be nonpathogenic and extremely safe may be used under the minimal closed condition (GILSP Application). Others may be used under a closed condition (Category 1-3) according to its degree of safety.

(ii) Application in an Open System

The effort from now on shall be to concentrate on accumulating adequate knowledge in safety. Definite criteria on safety shall be evaluated.

(b) Utilization of recombinant organisms shall proceed with furnishing the necessary equipment and facilities, and meanwhile assuring the safety.

(c) For utilization of recombinant organisms, enterprises may request the minister of AFF for confirmation of compliance with this guideline on safety evaluation, facilities, equipment, etc.

For issuing certification by the minister of AFF, the necessary investigation and evaluation will be conducted by the Special Committee on Utilization of Recombinant Organisms within the AFF Research Council. (For medicines for animals, this will be done by the Biotechnology Special Council of the Central Pharmaceutical Affairs Council.)

2. System of Guideline

Chapter 1--General Rules

I. Aim

The purpose of this guideline is to establish the basic conditions necessary for appropriate application of recombinant organisms that possess new forms and natures introduced by the DNA recombination technology in AFF and food industries and other industrial fields that come under the jurisdiction of MAFF, thereby assuring safety in the utilization of recombinant organisms and contributing to healthy development of various fields of AFF.

II. Definitions

Recombinant organism, host, vector, donor DNA, recombinant plant, recombinant microorganism, work area, work field.

Chapter 2--Safety Evaluation

I. Principle

The enterprise shall conduct an overall evaluation of the safety of the recombinant organism by combining the evaluation of the characteristics of the recombinant organism, based on the properties of the host, the recombinant DNA molecule and the vector, according to the items listed in II, and comparing these with the host, etc. Utilization of the recombinant organism shall proceed in accordance with its kind, application form, and degree of safety.

[Recombinant Plants]

(1) In the event that a recombinant plant is to be propagated for obtaining the necessary breeding material, it shall be handled in a simulated environment to confirm its safety in an open system.

(2) After its safety has been confirmed in (1), a recombinant plant may be handled in an open system.

[Recombinant Microorganisms]

(1) Utilization in a Production Process: Depending on its degree of safety, such as pathogenicity, etc., a recombinant microorganism shall be classified into an application class of GILSP or Category 1-3, and utilized.

(2) Utilization Aiming at Application in an Open System: For production, item (1) shall be followed. After the safety evaluation, safety in the open system application shall be confirmed by using a simulated environment for handling. After safety confirmation, a recombinant microorganism may be handled in an open system.

II. Items To Be Evaluated

[Recombinant Plants]

(1) Purpose of application of the recombinant plant
(2) Host and biological species of the host
(3) Donor DNA
(4) Vector
(5) Recombinant plant
(6) Others (knowledge, observations, etc., obtained during DNA recombination experiments and cultivation)

[Recombinant Microorganisms]

(1) Purpose of application of recombinant microorganism
(2) Host and biological species of the host
(3) Donor DNA
(4) Vector
(5) Recombinant microorganism
(6) Others (knowledge, observations, etc., obtained during DNA recombination experiments and propagation)

III. Classification of Applications

[Recombinant Plants]

(1) Application in a Simulated Environment: Experimental application in a definite confined area that simulates the environment where the recombinant plant is to be cultivated. The experiment is to be conducted under the condition that measures for prevention of propagation of the plant outside the confined area and contamination by pollen, etc., are in place.

(2) Application in an Open System: Application in an open system for those confirmed to be safe.

[Recombinant Microorganisms]

(1) Application in a Production Process: GILSP (Superior Industrial Manufacturing Rules) Application (minimal enclosure), Categories 1-3 Applications (specific enclosure according to characteristics).

(2) Utilization Aiming at Application in an Open System:

Application in a Simulated Environment: (Application of a recombinant microorganism classified in (1) as GILSP or Category 1. Experimental application in a specific confined area that simulates the environment where the microorganism is to be discharged under conditions which minimize dispersion to the outside of the confined area and the transmission of the genetic phenotype.)

Application in an Open System: Application in an open system of those confirmed to be safe.

Chapter 3--Concerning Handling of Recombinant Organism, Facilities, Equipment, and Handling Methodology

I. Facilities and Equipment for Handling Recombinant Organisms

[Recombinant Plants]

(1) Defining and establishing the work area.

(2) The forms of reproduction and propagation, male sterile treatment, physiological characteristics, and the biota of the surroundings shall be taken into consideration in setting aside isolation areas as needed.

[Recombinant Microorganisms]

Application in a Production Process

The necessary work area shall be established according to the individual degree of safety, GILSP Application or Categories 1–3 Applications, and the facilities and equipment possessing the necessary degrees of enclosure shall be furnished.

Applications in Simulated Environments

(1) The work area shall be defined and established.

(2) The necessary isolation area and the facilities needed for management shall be set up inside the work area with consideration for the form of propagation, the measure for limiting the propagation capacity, the form to be used in the open system, and the biota of the surroundings.

II. Methodology for Handling Recombinant Organisms

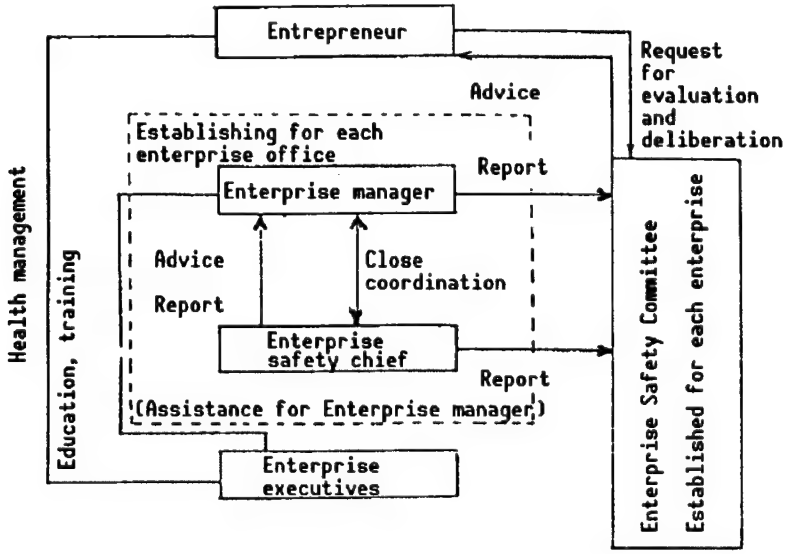
[Recombinant Plants]

(1) Culture management, etc.
(2) Waste treatment
(3) Storage
(4) Transportation
(5) Maintenance of facilities and equipment
(6) Others

[Recombinant Microorganisms]

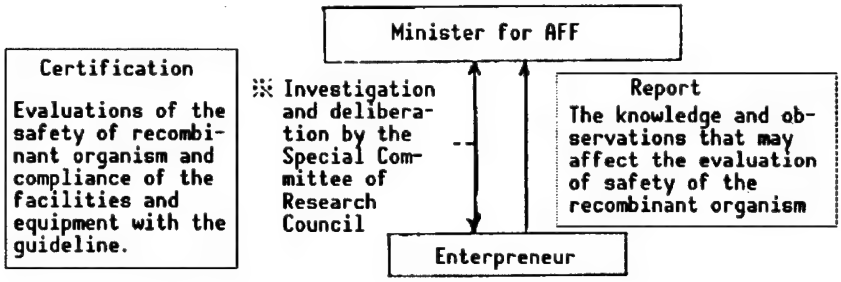
(1) Culture management, etc.
(2) Waste treatment
(3) Storage
(4) Transportation
(5) Maintenance of facilities and equipment
(6) Others

Chapter 4—Management System, Etc.



Note: The parts inside boxes are rules concerning recombinant microorganisms intended to be used in open systems. The method for definite estimation of their safety needs further evaluation.

Chapter 5—Certification and Report



Note: The investigation and delibration shall be conducted by the Special Committee on the Utilization of Recombinant Organisms of AFF Research Council for certification by the minister for AFF.

Chapter 6—Others

1. For recombinant microorganisms designed to be applied in open systems, efforts shall be made to accumulate adequate knowledge and observations concerning their safety.

2. Recombinant animals shall be raised and managed in definite managed areas, and certification shall be considered individually, case by case, at present.

3. The rules regarding the recombinant microorganisms shall also be applied to noncellular recombinant materials (used for directly inoculating animals or plants).

4. Self-cloning, etc., shall be temporarily treated as recombinant organisms.

5. The items concerning the operation, the method of recording, etc., shall be decided separately by the heads of the Secretariat, the AFF Research Council, and other involved bureaus and agencies.

Reference

A Chronological Table of Events Concerning DNA Recombination Technology

Date	Japan	Overseas
Jun 73		U.S.: The problem of danger latent in DNA recombination discussed at the Gordon Conference on nucleic acids.
Aug 74		U.S.: Paul Berg called for a temporary moratorium on gene recombination experiments.
Feb 75	More than 10 molecular biologists assembled and agreed to adapt Paul Berg's proposal.	U.S.: Asilomar Conference held. (An international conference on the problem of regulating gene manipulation)
Jun 76	"Plasmid Problem Evaluation Subcommittee" established within Biological Science Research Communication Committee, the Science Council of Japan.	U.S.: NIH Guideline issued.
Aug		U.K.: Publication of Guideline for DNA Recombination Experiments; establishment of Genetic Manipulation Advisory Council [GMAC].
Sep	First Conference on DNA Recombination Research held in Life Science Division Meeting, Science and Technology Confer.	

[Continuation of table]

Date	Japan	Overseas
Jan 77	"Interim Report on Evaluation of DNA Molecule Recombination Research Working Group" submitted to the Plasmid Subcommittee.	
Jul	First meeting of the DNA Recombination Subcommittee, Science and Society Special Committee, Science Council, held.	
Dec		France: Publication of Guideline for DNA Recombination Experiments.
Feb 78		W.Germany: Publication of Guideline for DNA Recombination Experiments.
Mar 79	"Guideline for DNA Recombination Experiments in Universities, Etc." issued by Ministry of Education, Culture, and Science.	
Aug	"Guideline for DNA Recombination Experiments" issued by STA.	
Nov 80		U.S.: Revision of NIH guideline (registration not required for host vector line of *E. Coli* K12 variant, leaving to the discretion of researcher, etc.).
Jul 81		U.S.: Revision of NIH guideline (exemptions for host vector lines of K12 variant, yeast, *Bacillus subtilis*; establishment of standard for vertebrate toxins).
Mar 82		32nd OECD/CSTP: Discussion on future policy concerning examination of "Biotechnology and Policy."
Aug	Overall revision of "Guideline for DNA Recombination Experiments" (relaxation of standards of physical and biological enclosures, expansion of range of applicable microorganisms, etc.).	

[Continuation of table]

Date	Japan	Overseas
Feb 83		34th OECD/CSTP: "Safety of Biotechnology and Its Regulation" taken up as a formal discussion subject; establishment of an expert group.
Sep	Revision of "Guideline for DNA Recombination Experiments" (establishment of standard for large-scale cultures, establishment of Level B for biological enclosures).	
Dec		OECD: 1st Ad Hoc Group meeting (examination of agenda, discussion of mandate, scheduling meeting date).
Jun 84		OECD: 2nd Ad Hoc Group meeting (examination of report).
May 85		OECD: 3rd Ad Hoc Group meeting (examination of report). Australia: "Guideline Concerning Environmental Discharge of Recombinant Organisms" issued.
Sep	AFF DNA Recombination Technology Promotion Research Conference launched by MAFF (for evaluation of ideal methods for safe application of recombinant organisms in AFF fields, subdivided into plants and microorganisms. The evaluation meeting was held 11 times up to May 1986.).	
Apr 86		U.K.: Guideline for planned discharge of genetically manipulated organisms for application in agriculture and environment issued.
Jun	"Guideline for Industrialization of DNA Recombination" issued by MITI. A report, "On Application and Safety Assurances of Recombinant Organisms in AFF Fields" issued by the AFF DNA Recombination Technology Promotion Research Conference.	U.S.: Framework for modifying regulations concerning biotechnology published. U.S.: S&E biotechnology guideline inclusive of field tests of animals, plants, etc., issued by USDA.

[Continuation of table]

Date	Japan	Overseas
Jun 86		U.S.: Commencement of field tests of herbicide-resistant tobacco and insect-resistant tobacco.
Jul		OECD: Advice on problem of safety concerning industrial applications of recombinant organisms issued.
Aug	Revision of "Guidelines for DNA Recombination Experiments" (establishing a LS-C Level for large-scale cultures, adding host-vector lines of industrial microorganisms to those covered by the guideline).	
Oct	First certification of industrialization plans under the industrialization guideline issued by MITI. (Thereafter, until April 1990, 160 cases from 23 companies had been certified by 17 issuances of certification.)	
Dec	"Guideline for Application of DNA Recombination Technology in Manufacturing Medicines and Drugs" issued by MHW. "Proposed Guideline for Application of Recombinant Organisms in AFF Fields" published by MAFF.	
Mar 87	First certification of manufacturing plans under guideline for manufacturing medicines and drugs issued by MHW. (Thereafter, 68 items in 32 cases from 32 companies had been certified in 13 issuances up to February 1990).	
Apr		U.S.: Field trial of recombinant bacterium for prevention of frost damage started (the first formally recognized field trial of a recombinant microorganism).

[Continuation of table]

Date	Japan	Overseas
May 87	MHW guideline revised to "Guideline for Application of Recombination Technology in Manufacturing Medicines and Drugs, and Others," to be applied also to nondrug items, cosmetics, and therapeutic devices.	
Jul		U.S.: USDA decided on regulations concerning handling of APHIS recombinant plants (defining criteria of evaluation, etc., 7 CFR 340).
	A list of requests concerning the practical application of guidelines submitted by DNA Recombination Technology Division, Life Science Committee, Keidanren to various ministries and agencies.	
Apr 88		OECD: A meeting of biotechnology safety experts held.
May		U.S.: A report, "Genetically manipulated organisms in the environment" issued by OTA.
Dec	STA indicated its thought on recombinant plant experiments in nonclosed systems.	
Apr 89	"Guideline for Application of Recombinant Organisms in AFF Fields" established and issued by MAFF.	
Sep		U.S.: NRC, U.S. Academy of Science issued a report, "Framework for Judging Field Tests of Recombinant Organisms."
Oct	NIABR, MAFF commenced experiments on recombinant tomato in nonclosed systems.	
Dec	Safety Evaluation Conference, Subcommittee for Evaluation of Guidelines for DNA Recombination Experiments, Science Council, completed an interim report, "On the Revision of Guideline for DNA Recombination Experiments in Universities."	

[Continuation of table]

Date	Japan	Overseas
Dec 89	First certification of recombinant organisms application plans issued by MAFF under the guidline.	
Mar 90		OECD: "A Test Case for Argument: GDP (Good Development Plan) for small-scale, simulated field experiments of recombinant organisms" issued.
Apr		EC: The directive of the council of cabinet members concerning planned discharge of genetically manipulated organisms into the environment adapted.
May 90		W.Germany: Genetic Engineering Law announced.

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